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Intermountain Region
Rocky Mountain Region

1983 Update

New Directions in Management on the Bighorn, Shoshone & Bridger-Teton National Forests

Wyoming Forest Study Team

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Wyoming Forest Study Team

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R. Burton Litton, Jr.
L. Jack Lyon
Paul E. Packer
P. Max Rees
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United States Department of Agriculture
Forest Service

Intermountain Region
Rocky Mountain Region

March 1983

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Wyoming Forest Study Team

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Acknowledgment

Technical photographs which illustrate the report were taken by study team members in 1970 and on follow-up visits in 1982. Supplemental photographs on pages 2, 3, 4, 22, 23, 24, and 35 are courtesy of Regions 2 and 4 and the Forest Service Photo Library in Rosslyn, Virginia.

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Back to Wyoming

In 1970, motivated by public concerns about excessive clearcutting on Wyoming's national forests, the USDA Forest Service assigned six resource scientists to the Wyoming Forest Study Team.

Could career Forest Service professionals objectively evaluate the performance of the study Forests? Would they acknowledge controversial issues and public criticisms? Would they pinpoint areas for improvement and venture to make recommendations? And, would the Forest Service publish such a report? The answers were in the affirmative and the publication is history. *Forest Management in Wyoming: Timber Harvest and the Environment on the Teton, Bridger, Shoshone, and Bighorn National Forests* appeared in 1971.

Regional Foresters subsequently directed the study Forests to adopt most of the recommendations presented in what has come to be known as the Wyoming Report.

Now 12 years have passed. New issues are emerging. Voices of public concern have recently been heard regarding national forest management trends in Wyoming. In response, the Forest Service, with a tradition of periodic reevaluation, determined that a follow-up report was in order. The study Forests are located in Regions 2 and 4 of the National Forest System. The Regional Foresters contacted Governor Ed Herschler and the Wyoming Congressional Delegation to discuss public concerns for quality management of the State's forest land resources. Correspondence followed, and it was agreed to invite the original study team back to update the 1971 Wyoming Report.

This is how in 1982 the same six resource scientists had the rare opportunity to come together and do it again. Fortunately, all six were available and accepted the invitation, even though four members had since retired from the Forest Service. Representatives from the Governor's office were asked to join the team, and three state natural resource analysts participated in the review.

The team's new instructions were to evaluate the 1971 recommendations on the same national forest land--the Bighorn, the Shoshone, and the Bridger-Teton (the Bridger and the Teton were merged administratively in 1973). Recommendations on current management practices were to be made for consideration by the Regional Foresters. Changes may be necessary due to the new directions in forest management which are resulting from recent legislation, emerging regional and national trends, and advancements in timber management technology. The team was to explore public concerns of individuals and organizations in a thorough, objective, and impartial review.

As in 1970, the team's fact-finding process involved verbal and written communications with concerned people--

- those who view remaining roadless areas as untouchable,
- those who see the forest as a source of raw material for the lumber industry,
- those whose business may be affected by compromising the pristine quality of the land with timber harvesting,
- those who hold big game as the prime resource value,
- those who view the environment as an esthetic resource,

- those who welcome extension of the road system for better recreation access, and
- those who earn a living at the logging and milling trades.

Some might conclude that such a mix of ''wants'' defies resolution; the team did not. This cross section of public interests forms a matrix of what national forest management on the ground should be.

The Forest Service, known for a decentralized system of administration, authorizes a substantial amount of decisionmaking by field units. Forest personnel are encouraged to modify management practices to meet local conditions. Yet by law, the agency is directed to serve national needs as well. The spectrum of Forest Service clients, in the State and in the nation, requires responsiveness to all. Authority and flexibility of local forest units is emerging as a central issue in current Wyoming forest controversies.

Contacts with personnel on the three study Forests revealed allegiance to the Forest Service and dedication to responsible forest management. Along with successes, the team was shown some failures. On these occasions, forest personnel were ready to admit, ''We goofed,'' but followed with, ''We can do better.'' In addition to professional pride, the team was impressed with those staff members who showed appreciation of Wyoming's starkly beautiful landscape and abundant wildlife. Forthright statements by forest personnel, along with free access given the team to harvesting reports, regeneration surveys, and other information sources, were essential for a thorough evaluation.

Although communications with concerned citizens and elected officials were open and unstructured, the team's time schedule was not. The planning and orientation phase began in February 1982. Letters were sent to 235 key people in Wyoming, many of whom replied with detailed, thoughtful statements. The team then categorized correspondence as concern or support regarding current forest management.

This springtime exercise was completed in preparation for the beginning of a scheduled mid-June air and ground examination of the Forests. Inaccessibility, due to a persistent snowpack, delayed the on-site phase of the study. Finally, on July 25, the team congregated in Jackson, Wyoming. The next 12 days, spent traveling on the study Forests, constituted total-emersion involvement. Orientation discussions, forest field trips, flyover examinations, public and private meetings, motel-room critiques, closeout sessions, and the obligation to get on with the job, all fused into a day-night-weekend marathon, which was, incongruously, too short.

Time was short, and provisions were made for a return trip in September by part of the team to complete unfinished business. Even with a return visit, the team cannot claim to have analyzed in exhaustive detail all concerns expressed. Within time constraints imposed, the team endeavored to carry out the review charge in a professional and impartial manner. In formulating recommendations, team members realize that some forest management decisions are made as administrative matters outside the purview of the evaluation. The team's purpose was not to critique national forest policy, but to determine how effectively existing policies are being carried out. It is the intent of the team and its sincere wish that statements of concurrence and recommendations contained in the 1983 update report may contribute to improved management for the national forests of Wyoming.

Contents

Introduction.....1
  Bighorn National Forest.....2
  Shoshone National Forest.....3
  Bridger-Teton National Forest.....4

Policy: New Directions.....5
  Planning Process.....5
    Environmental Assessments.....8
    Public Participation.....9
  Economic Perspectives.....11
  Local-State-Federal Coordination.....13

Practices: Innovation and Experience.....15
  Timber Harvesting.....17
    Silviculture.....17
    Ecology.....27
    Proposed Harvesting in Unroaded Areas.....29
    Rate of Harvest.....30
  Wildlife Habitat.....35
    Wildlife and Timber Harvesting.....36
    Wildlife Biologists.....40
    Technical Information.....40
    Roading Influences.....41
  Landscape Design.....43
    Visual Management System.....44
    Diversity.....46
  Hydrology.....53
    Water Quality.....53
    Water Yield.....56
  Road Design and Maintenance.....59
    Road Construction.....61
    Road Closures.....63

Problems: Emerging and Remaining.....65
  Staffing and Funding.....65
  Recreation.....67
  Oil and Gas Exploration.....69
  Site Rehabilitation.....71

Recommendations: Then and Now.....75
  Response to 1971 Recommendations.....75
  Summary of 1983 Recommendations.....83

Literature Cited.....88

Table 1. Legislative History of National Forest Management

1895	Organic Administration Act		The Organic Act identified purposes of forest management as forest protection and improvement, protection, of waterflow, and timber supply.
1960	Multiple Use Sustained Yield Act	MU-SY	MU-SY specified that national forests shall be administered for outdoor recreation, range, timber, watershed, wildlife, and fish purposes. High-level periodic resource outputs were not to impair productivity of the land.
1964	Wilderness Act		The Wilderness Act called for preservation of some forest lands with pristine characteristics by designation as wilderness areas. It directed the Forest Service to review certain areas for wilderness classification.
1969	National Environmental Policy Act	NEPA	NEPA directed that unquantified environmental amenities and values be given appropriate consideration in decisionmaking. It established the Council on Environmental Quality.
1973	Roadless Area Review and Evaluation	RARE I	This review by the Forest Service, begun in 1967 and completed in October 1973, inventoried roadless areas of 5,000 acres or more in western national forests. RARE I recommended 12.3 million acres for further study as possible wilderness. Public dissatisfaction with the review eventually led to RARE II.
1973	Endangered Species Act		This act, reauthorized in 1982, provided a program to conserve ecosystems upon which endangered or threatened native fish, wildlife, and plant species depend. It directed that necessary steps be taken to improve the wellbeing of such species to the point where survival is assured.
1974	Forest and Rangeland Renewable Resources Planning Act	RPA	RPA called for an inventory and assessment of all forests and rangelands in the United States and an analysis of present and anticipated supply and demand for forest and rangeland resources at 10-year intervals. The act called for a national program updated at 5-year intervals to protect, develop, and manage forests and rangelands administered by the Forest Service.
1976	National Forest Management Act	NFMA	NFMA amended RPA. It provided criteria for interdisciplinary land and resource management plans. Outdoor recreation, range, timber, watershed, wildlife, fish, and wilderness resources are to be incorporated into regional and forest plans by 1985.
1979	Roadless Area Review and Evaluation	RARE II	RARE II, begun in 1977 and completed in January 1979, inventoried roadless areas of 5,000 acres or more in eastern and western national forests. Isolation and solitude criteria were considered in addition to the absence of roads. RARE II recommended 36 million acres for nonwilderness, 15.4 million acres for wilderness, and 10.6 million acres for further study. These recommendations are now before Congress.

Introduction

Wyoming has some of the first national forests in the country. Management by the USDA Forest Service began in the early 1900s with a fire protection program. Until mid-century, timber harvesting was largely for railroad cross-ties selected from the more accessible lodgepole pine stands. The harvests (locally called ''tiehacking'') were sporadic operations which employed from a few up to several hundred woodsmen. Small volumes of timber were also cut for lumber, posts, and poles. These mostly ''high-grading'' operations used horses and small machines to remove only the bigger, better trees.

Extensive and costly insect control programs were begun in the 1930s. Infested trees were felled and burned or treated with chemicals. Frequent and widespread mountain pine beetle epidemics were the target. Decimation by this forest pest has been so extensive as to render the presence of other insect pests inconsequential. Treatments were regarded as a holding action. Their purpose was to protect remaining timber stands until market demands would permit harvesting and subsequent establishment of young trees less susceptible to beetle attack. No public controversies were recorded concerning the insect programs.

These efforts were discontinued in the early 1960s. The acreage of old growth timber susceptible to infestation was so large that control was unfeasible. Developments in timber harvesting and milling technology, together with increased demands for lumber, changed the economics of harvesting lodgepole pine. Managers of the national forests saw an opportunity through timber harvesting to convert deteriorating old forests to young vigorous ones. Over time, such conversion would reduce loss to insects and disease, contribute to local economies by creating new jobs, and help to meet the increasing demand for lumber. Generally, the harvesting was welcomed as an improvement. The outlook appeared positive, both socially and economically.

The lumber industry, encouraged by the Forest Service and local communities, installed sawmills at strategic locations near the study Forests. Soon, hundreds of acres of lodgepole pine and some spruce were being clearcut, mills were operating at full capacity, and plans were under way to expand timber harvesting to the sustained yield levels indicated by timber inventories.

Meanwhile visual impacts of clearcutting and associated road development had begun to alarm Wyoming residents. The result was organized opposition. A widespread concern was voiced that continued timber harvesting in the high-altitude forests of Wyoming would have adverse effects on soil, water, landscape, fish, and wildlife. A deep-felt belief spread that new trees could not be re-established on harvested areas. These concerns took on special currency in association with nationwide attention to environmental quality in the 1960s.

Public criticism directed at management of national forests in Wyoming, as well as in other parts of the country, led to substantial changes in Forest Service policy. The public cry for a blue ribbon committee to examine the clearcutting problem in Wyoming was countered by the Chief of the Forest Service who called for an in-house study. Forest personnel had recognized shortcomings and Regional Foresters of Regions 2 and 4 helped assemble the 1970 Wyoming Forest Study Team.

In the decade since publication of the Wyoming Report, a number of resource management laws have been passed by Congress and implemented by the Forest Service.

ERRATA

"1983 Update New Directions in Management on the Bighorn, Shoshone & Bridger-Teton National Forests," page 3, Figure 3: "The grizzly bear, classified as an endangered species, ..." should read "The grizzly bear, classified as a threatened species, ..."

Table 1 presents a summary of legislation important to forest management. Proposals for additional wilderness designations on the three study Forests are currently before Congress (Livingston et al. 1979).

Since 1970 Wyoming has been changing along with forest management. Population has increased over 50 percent due primarily to an energy boom with extensive exploration and development by coal, oil, and gas industries. Mineral industries have become the backbone of economic growth in the State. Recreation/tourism and agriculture follow in order. Logging, milling, and wood manufacturing are considered of local economic importance.

While forest products may not be a major industry in Wyoming, timber harvesting is an essential forest management tool. Without it, little could be done by way of manipulating vegetation for multiple-use benefits, such as improved wildlife habitat, increased water yield, and expanded recreation opportunities. With projected mineral development and resulting population increases, more demands may be anticipated for an array of forest resources from the study Forests. Now more than ever before, forest managers need to recognize the national significance of wildlife and scenic resources unique to this area. Located in western and northern Wyoming, the study Forests each have a distinctive history, geologic structure, blend of plant and animal species, and make-up of local communities.

Bighorn National Forest

Once the hunting ground of the Sioux, Cheyenne, and Crow Indians, the Bighorn encompasses over a million acres in a strip 30 miles wide by 80 miles long, with headquarters at Sheridan. About 7,800 acres of State and privately owned land are included within the Forest boundaries, and 137,000 acres are classified as the Cloud Peak Primitive Area. The Wyoming Wilderness Act, now before congress, would combine the primitive area with 21,000 adjacent acres to form the Cloud Peak Wilderness.

Slightly more than half the land area is forested. Lodgepole pine, Engelmann spruce, and subalpine fir occupy 85 percent of forested land with the remainder in Douglas-fir, aspen, and ponderosa pine. Nonforested areas are characterized by high mountain meadows, grasslands, and shrublands--mostly sagebrush.

Bighorn sheep are present but in decreasing numbers. Mule deer, elk, moose, black bear, and coyote attract hunters to the Forest. Trout-filled lakes and streams backed by mountain meadows and evergreen forests form a recreation area favored by residents and visitors of eastern Wyoming.

The Medicine Wheel, an archeological site on a windswept ridge, is a puzzling prehistoric rock structure. Laid out in 28 spokes, the wheel has a diameter of 70 feet. Indian legend cannot explain its origin.

Figure 1. The Bighorn is known as a good hunting forest and mule deer are a prized game animal.

Figure 2. Rolling and forested terrain leads to the rugged Cloud Peak Primitive Area (Little Goose Park, Bighorn).

Shoshone National Forest

The Shoshone, named for local Indian tribes, has headquarters in Cody. Three wilderness areas (Absaroka, Washakie, and Fitzpatrick) and two primitive areas (Glacier and Popo Agie) occupy over half the Forest's 2.43 million acres. Congress is considering converting 78,000 acres in the primitive areas and an additional 42,000 acres to wilderness.

About 40 percent of the Shoshone is forested. Lodgepole pine and Douglas-fir predominate. Engelmann spruce, subalpine fir, whitebark pine, and aspen are also important trees. About 20 years ago, lodgepole pines were hit by an epidemic of mountain pine beetle which killed half the trees in many stands. Comandra blister rust also attacked lodgepole pine stands leaving up to 60 percent of trees with dead spiketops. As a result, many overstories are gray in color and understories choked with fallen trees.

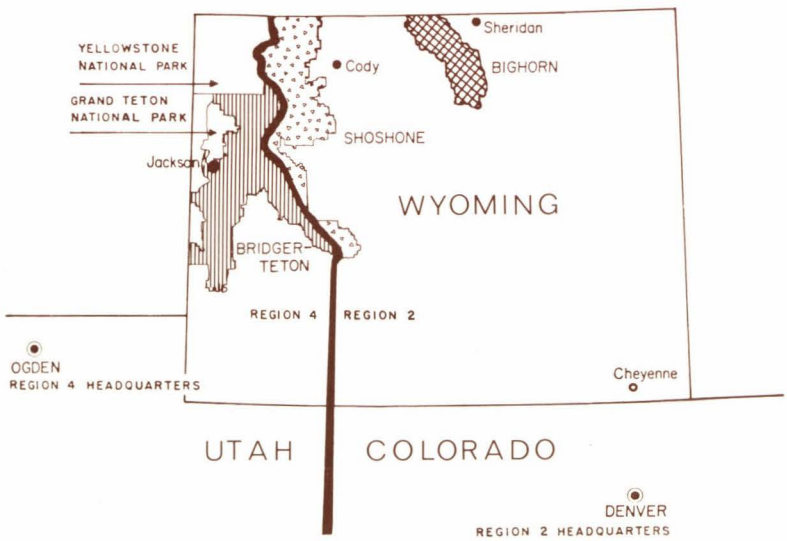
The Shoshone boasts that it is the only national forest in Wyoming in which all of the following animals can be found: elk, mule deer, white-tailed deer, bighorn sheep, mountain goats, antelope, moose, black and grizzly bears, wolves, and coyotes. Bald and golden eagles soar and songbirds and waterfowl are plentiful.

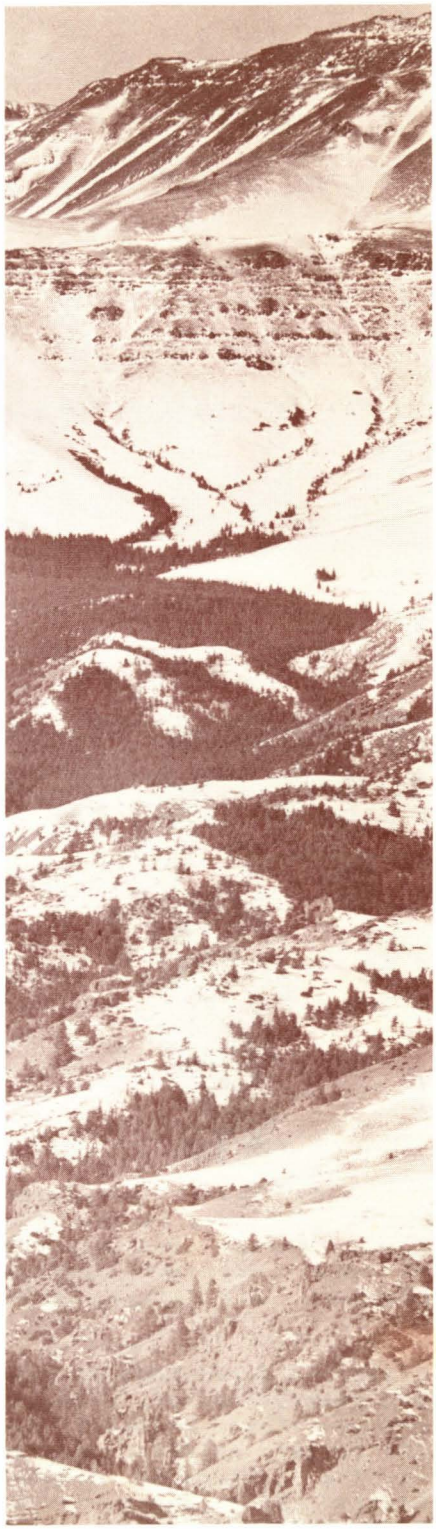
Major highways, passing through the Forest, lead to the eastern and southern entrances of Yellowstone National Park. Each year, thousands of visitors spend part of their vacation time on the Shoshone enjoying the spectacle of mountain peaks set in a mosaic of contrasting vegetation.

Figure 3. The grizzly bear, classified as an endangered species, requires protective habitat management.

Figure 4. High mountains and basins with diverse vegetation types lure thousands of visitors each year (Trout Peak, Shoshone).

Figure 5. Location & boundaries of the Bighorn, Shoshone, and Bridger-Teton National Forests.





Bridger-Teton National Forest

The Bridger and Teton National Forests were joined administratively in July 1973 with headquarters in Jackson. Within Forest boundaries are some 3.4 million acres of federally owned land and about 40,000 acres of State and private land. The Bridger and the Teton wilderness areas encompass 950,000 acres. Congress is considering another 257,000 acres for wilderness classification, including the proposed Gros Ventre Wilderness.

About 65 percent of the land is forested. Lodgepole pine predominates followed by subalpine fir, Engelmann spruce, Douglas-fir. and aspen. Streams from the Forest ultimately drain into the Atlantic, Pacific, Gulf of California, and Great Salt Lake. The Overthrust Belt, a geologic structure with rich deposits of oil and gas, traverses the Forest.

The Bridger-Teton elk population--estimated at 30,000--is larger than that of most states. Moose, deer, antelope, bighorn sheep, and black bear are abundant. Designated endangered species include the grizzly bear, wolf, peregrine falcon, bald eagle, whooping crane, and Kendall Warm Springs dace.

The Bridger-Teton, together with adjacent Teton and Yellowstone National Parks and the National Elk Refuge, is recognized as the premier outdoor recreation area in the United States. More than 4 million people pass through Jackson Hole annually and half spend at least part of their time on the Bridger-Teton with its high striking mountains, placid flats and uplands, lakes, rivers, streams, and parklike forests.

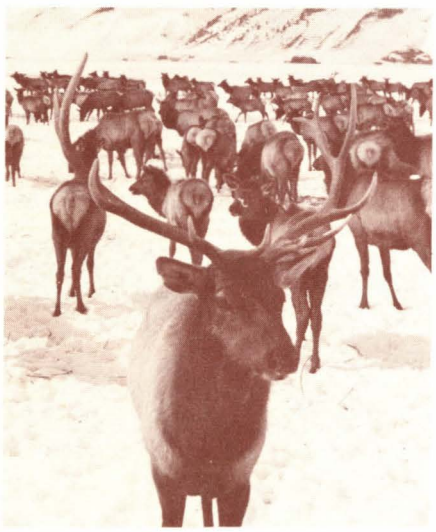


Figure 6. The Bridger-Teton elk herd summers on the national forest and winters on the adjacent refuge (National Elk Refuge, Jackson).

Figure 7. A panorama of jagged peaks, forests, meadows, and grasslands characterizes the largest national forest in the contiguous United States (Gros Ventre Range, Bridger-Teton).

Policy: New Directions

People in Wyoming want to know projected plans for the national forests and particularly for undeveloped lands. Will roads be built for recreation and timber harvest access or will some areas remain unroaded and pristine? Can wildlife thrive unmolested by human activities and undisturbed by livestock grazing? Should some additional areas become part of the wilderness system? Management direction was the emerging issue met by the 1982 Wyoming Forest Study Team. Local communities called for balance in forest management objectives. Critics contended that commodity uses--timber harvesting, livestock grazing, energy development--were given priority, while amenity values--wildlife, outdoor recreation, scenic beauty--were de-emphasized. Others were certain the reverse was true. They felt emphasis on amenities was preventing sound multiple-use management.

The study team heard comments that the Forest Service was headed in the right direction, but at times on-the-ground accomplishments did not meet expectations. Some people questioned the economics of managing forested lands on the three Forests for commercial timber. They viewed high-elevation lands with low productivity and high harvesting costs compared to forests elsewhere in the nation and concluded that timber harvesting was uneconomical and environmentally unsound. Others contended that, in addition to receipts to the treasury and jobs generated, timber harvesting resulted in important long-term benefits to wildlife, esthetics, watershed, recreation, and livestock forage.

A common complaint heard by the team stated that it was difficult, if not impossible, to get information from the Forest Service about plans for future road locations. Public concern appears to stem from uncertainty about the direction of future forest management.

Planning Process

Federal law directs the USDA Forest Service to manage national forests in accordance with principles of multiple use and sustained yield. Decisionmaking by forest managers is guided by a number of acts and USDA regulations, many of recent origin. This legislation has been enacted to guide the Forest Service in maintaining long-term productivity and in achieving a balance of physical, social, and economic objectives.

Of major significance to the study Forests was passage in 1974 of the Forest and Rangelands Renewable Resources Planning Act (RPA) and in 1976 of the National Forest Management Act (NFMA). Table 1 on page vi presents a legislative summary. A citizen's guide to RPA (USDA Forest Service and Conservation Foundation 1981) said in part:

> The Resources Planning Act and the National Forest Management Act, which amends it, mandate the most ambitious resources planning effort ever attempted by this country. Over the next 5 years, as National Forest Plans are completed, state forestry plans developed, and the RPA program updated, thousands of people representing diverse interests and segments of society will review, comment on, and argue over the management proposals for individual forests and the direction of forest policy, regionally and nationally.

The national program covers all Forest Service activities--management of the 187-million acre National Forest System, support of State and private forestry, and forestry research. Management goals and resource objectives included are based upon resource capabilities, demands, and projected levels of funding and personnel.

RPA and NFMA include direction for the development and structure of forest plans at the national, regional, and forest levels, all of which are updated periodically and subjected to the environmental impact statement process. At the national level, the plan consists of an assessment and a program. Regional Foresters, within the context of the national plan, establish direction, standards, and guidance in the format of a regional guide. Resource objectives, funding, and personnel are assigned to the Forests for implementation. Forest personnel then undertake their planning job. The directional flow may appear to be downward from the national level to the regions to the individual forests, but a vital complementary upward flow of forest resource information is also influential. Table 2 outlines the sequence of steps in formulating forest plans.

The three Forests have completed the process of identifying issues, concerns, and opportunities. Hundreds of comments on public issues were received from individuals and organizations by each Forest. People outside the Forest Service, with whom the study team

Table 2. Steps in Formulating

1.	Identifying Issues Concerns Opportunities	Meetings with public interest groups and local governments, letters, and individual contacts are used to encourage public response. Information obtained on economic, social, cultural, biological, and other factors influences development of management alternatives.
2.	Establishing Planning Criteria	Included are standards to be used in evaluating data collecting and alternatives; analyzing public comments; establishing assumptions and economic analyses; coordinating with other public agencies; and applying Forest Service and NEPA regulations and guidelines.
3.	Compiling Data	The Forest Supervisor is charged with assuring that ecological, technical, economic, social, and cultural information is available. Resource data is accumulated and maintained for plan monitoring and evaluation.
4.	Analyzing Management Situation	The ability of areas covered by the forest plan to supply goods and services in response to society's demand is examined as required by NFMA. Included are ranges of goods and services feasible at various levels of management intensity; demand projections; potentials for resolving issues and concerns through Forest Service action; technical, economic, and environmental feasibility of the program (resource objectives assigned by Regional Foresters); and need for change in management direction. The analysis is submitted for Regional Forester review and approval.
5.	Formulating Alternatives	Alternative courses of action are developed, reflecting a range of accomplishment. Regulations require that each alternative be reasonable; ''no action'' alternatives be included (no change in current management); an alternative be developed to incorporate RPA tentative resource objectives assigned to the Forest by the Regional Guide; alternatives address each major public issue, management concern, and resource opportunity; the alternatives present cost-efficient management prescriptions to achieve stated objectives; alternatives facilitate evaluations of opportunity costs, resource use, environmental trade-offs, present net value, and net public benefits; alternatives state condition and uses in the long term, goods and services to be produced, resource standards and guidelines, and purposes of proposed management.

corresponded or visited, felt the Forests had done a good job involving the public. Complaints about this aspect of the process were that sometimes the Forest Service ''didn't listen.'' The problem may be that identifying issues constitutes only the first step in resolving conflicts between sometimes competing interests.

The three Forests have developed planning criteria and have or will soon have completed data and information collection and compilation. Marked progress has been made in accumulating resource information which the study team often found lacking or minimal a decade ago. Improved data is now available on wildlife habitat requirements, endangered species, outdoor recreation opportunity and demand projections, energy and mineral resource potential, forage for livestock and wildlife, stratification and potential yield of timber stands, habitat types for forested lands, soils, land forms, and landscape attributes. A better grasp of economic, social, and cultural situations in localities immediately influenced by management of the Forests was observed. A positive ''spin-off'' from the planning process is that forest personnel now have an increased understanding of data deficiencies and research priorities.

The next step in the planning process, analysis of the management situation, is time-consuming and difficult. Loan copies of analysis reports are available on the Forests for public review and comment. The Bighorn and

New Forest Plans

6.	Estimating Effects of Alternatives	An interdisciplinary team estimates and displays the physical, biological, economic, and social effects of each alternative. Examinations measure response to RPA resource objectives assigned to the forests by the Regional Forester. Included are relationships between local, short-term uses of forest and rangeland resources and maintenance and enhancement of long-term productivity. Irreversible and irretrievable resource commitments are identified. Each alternative is subjected to a rigorous economic and environmental ayalysis required by NEPA.
7.	Evaluating Alternatives	Alternatives are evaluated on the basis of significant physical, biological, social, economic, and environmental design effects. The Forest Supervisor examines the analysis and recommends a preferred alternative to the Regional Forester. After approval by the Regional Forester, the preferred alternative is assembled into a draft environmental impact statement (DEIS) and distributed for public review and comment.
8.	Selecting an Alternative	Public comments on the draft EIS weigh heavily in selection of the management alternative to be described in the final EIS. The Regional Forester reviews and approves or disapproves the proposed plan described in the final EIS.
9.	Implementing	The selected alternative is expanded and becomes the forest plan to be implemented on the ground. The Forest Supervisor assures that annual work plans are consistent with provisions in the forest plan.
10.	Monitoring and Evaluating	The final step is on-going monitoring and evaluation of implementation. The forest plan contains a monitoring schedule and a description of how monitoring will be accomplished. Monitoring determines if planned actions are being carried out, if they are resulting in intended effects, and if changes are needed. Management practices are evaluated to determine how closely guidelines have been followed and if modifications are required.

the Bridger-Teton have completed this phase and the Shoshone is working on it.

Formulating alternatives and estimating their effects were under way on the Bighorn and the Bridger-Teton during study team visits. The Shoshone was not far behind.

A draft environmental impact statement containing evaluations of alternatives was scheduled for completion early in 1983 on the Bighorn and for mid-1983 on the Shoshone and Bridger-Teton. The next step will be public review and analysis of comments received. An alternative will then be selected to establish the management direction of the final EIS and forest plan.

Federal regulations provide for changes in forest plans to accommodate differences between planned budgets and annually appropriated funds. Monitoring and progress of scheduled accomplishments may necessitate forest plan amendments at 5-year intervals. Revisions are ordinarily made on a 10-year cycle and at least every 15 years, but sooner if forest conditions or public needs change significantly (NFMA).

The National Forest Management Act provides that forests be managed under existing plans pending adoption of new forest plans. Areas recommended by RARE II for wilderness or for further study will continue to be managed to protect the wilderness option.

Plans now being developed will determine how the study Forests are to be managed in the foreseeable future. Adopted plans will replace existing management plans and, with minor exceptions, resource or functional plans currently used for timber, wildlife, landscape, and recreation. Project actions such as new roads, timber sales, and drill sites will require detailed planning subject to environmental assessments.

Environmental Assessments

Since 1960, the study Forests have prepared plans according to multiple-use management guides provided by Regional Foresters. Following passage of the National Environmental Policy Act in 1969, planning procedures at the forest level were modified and called unit plans.

Currently in some areas, the study Forests are following updated multiple-use plans. In other areas, the more recent unit plans are being employed.

Multiple-use surveys, which previously evaluated proposed management activities, have been replaced by environmental analysis reports and more recently by environmental assessments (EA).

The EA follows, at the site level, planning steps similar to those shown in Table 2 for forest plans. The environmental assessment is intended to assure that all resource values are considered and that potential influence of commodity production on non-commodity resources and of amenities on commodities are evaluated before a management alternative is selected. The study team reviewed EAs on each Forest to determine the adequacy of the procedure and its application.

Once an area is proposed for assessment, an interdisciplinary team is assigned to evaluate potential resource conflicts. Most teams have a silviculturist, a wildlife biologist, and a road engineer. A soils expert, a hydrologist, a landscape architect, a recreation specialist, and a fisheries or wildlife biologist may also be required. The interdisciplinary team meets as a group to consider the existing situation and probable changes associated with different alternatives.

Statements of public concerns regarding the area are considered. The study team was shown as many as 20 categories of concerns received from forest personnel, public groups, industry, and individuals. Among these

statements were plausible and useful suggestions. Most correspondence was acknowledged by forest personnel. Public involvement in EAs should have a positive effect on selection of appropriate management alternatives. The public will expect to see its input acknowledged in management decisions.

EA team members prepare back-up reports and the team leader compiles a final summary, evaluating alternatives which may range from ''no action'' to ''maximum manipulation.'' Though impressed by the interdisciplinary approach, the study team observed some indications of shortcomings. On-the-ground inspections and inventories of forest resources were not consistently conducted. The study team found no EA in which an adequate inventory of wildlife habitat use had been compiled prior to selection for timber harvest. In some instances, the EA was written without field inspection by a biologist. In others, the timber inventory was completed before the EA team met. The study team was told of situations where road layout and cutting unit boundaries were marked before other specialists were consulted. Input from specialists was then directed toward mitigating expected damage and preventing disruption of wildlife habitat and natural landscape rather than designing an alternative to enhance these values. Pre-sale inventories of forest resources would strengthen the EA process.

Current EAs describe management regimes far more sophisticated than the multiple-use surveys reviewed 12 years ago. A thorough and comprehensive EA, properly implemented, has the potential to be a process and document capable of guiding management through complex forest projects. Execution and on-the-ground achievement of objectives will be dependent, though, on an efficient monitoring system. Lack of monitoring was an area of weakness in all the EAs reviewed. Follow-up for evaluation was almost non-existent in every discipline on the Forests. Most timber sale EAs contained some provision for postsale monitoring of accomplishment but, as a rule, only regeneration surveys were specified. Postsale monitoring should be expanded to include wildlife, landscape, recreation, and water quality. Forest Service research staffs should perhaps be called on to train and advise forest personnel on monitoring techniques. EAs and the entire planning process will be judged by the public according to what is seen on the ground. Without follow-through, the best plans can go awry.

The study team visited Wyoming while new forest plans were being developed and could not judge the adequacy of an unimplemented process. It was the team's impression that integration of parts--EAs, site plans, silvicultural prescriptions, field advice of specialists, and monitoring--will be pivotal to success.

Public Participation

The study team sensed that the public in Wyoming was not fully informed about the planning process under way. Many who knew about the forest plans did not comprehend their importance in setting future management direction. Additional effort is needed to update the public on the planning process.

Questions were raised by the public about apparent differences in policy and practices from one Forest to another. Each Forest is authorized to be flexible in meeting local conditions, and valid reasons usually exist for different programs on the three Forests. Yet if reasons are not communicated to the public, the situation may be perceived as a lack of coordination. Introduction and testing of new technology may also be a factor. The

Regions and Forests should consider coordinating public information programs to keep local communities informed on reasons for differences in Forest programs and on developments in natural resource management.

Some people mentioned regret that citizen multiple-use advisory boards had been discontinued on the three Forests. A citizens consensus group was organized by the Bridger-Teton to share views with the community and to search for areas of agreement among varied interests on timber sale programs. The study team was invited to observe and participate in a meeting at Pinedale, Wyoming and was favorably impressed. Expanding such citizen groups or re-establishing multiple-use advisory boards should be considered by the Forests.

Providing public access to hearings and meetings regarding forest plans should be a priority. The public needs to know that new forest plans will identify road corridors for at least the 5-10 year period ahead. Plans will determine future wildlife habitat enhancement and outdoor recreation programs. Practices to protect water and air quality will be described and projections made for streamflow and water yield. Programmed timber harvests and areas with no scheduled harvests will be located for a specified time in the future. The economics of timber harvesting will be addressed including analytical processes and results. Once definitive answers on management direction are available some current controversies should be resolved and public confidence increased.

Recommendations

In the environmental assessment process, inventories of timber, wildlife, landscape, recreation, and archeological resources should be conducted prior to formulation of management alternatives.

The Forests should establish more effective monitoring programs, perhaps calling on Forest Service research staffs to train and advise personnel.

The Regions and Forests should consider coordinating public information programs to keep local communities informed about new forest plans, differences in Forest programs, and developments in natural resource technology.

Regional Foresters and Forest Supervisors should consider re-establishing citizen multiple-use advisory boards and expanding citizens consensus groups to encourage public involvement in forest planning and management.

Economic Perspectives

People in Wyoming want to know, ''How does the Forest Service evaluate public expressions of value?'' Forest management decisions, implicitly or explicitly, weight certain factors. The reasons for decisions should be explained to the public. Administrative and regional directives on timber harvesting goals, for instance, should be stated. Values assigned to wildlife, water production, esthetics, industrial stability, or return to the treasury should be clarified.

The goal of national forest management is not that combination of uses which gives the greatest dollar return or unit output, but that which yields the greatest net public benefits. Economic analyses are required for commodity values, but non-market and intangible benefits must also be weighed.

The Forest Service Manual, the regularly updated standard reference for national forests, contains specific principles which guide economic and social analysis for Forest Service programs, plans, and projects. Analytic principles are used to determine present net value and net public benefits.

Net public benefits signify the overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs), whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than by a single measure or index.

Present net value represents the difference between the discounted value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area.

Valuation of outputs is determined in accordance with standards set by the Chief of the Forest Service. RPA requires that standards be established by national valuation procedures, but values generally vary with geographic location. Innovative procedures may be used, but values significantly different from those used at the national level must be approved by the Chief. Projections of values for the planning horizon reflect only increases or decreases in real terms--changes resulting from factors other than inflation.

Costs include federal budget items (labor, services, and supplies) and other costs, such as those incurred by users in extracting products or in on-site uses. Costs are counted up through the stage at which benefits are measured. Results of specific management activities usually include several outputs and effects (joint production) and costs cannot always be determined for specific outputs. For example, a silvicultural prescription for a particular stand of timber may have several effects and produce several outputs--wildlife habitat, timber, watershed, and visual quality improvement. Total cost of implementing the prescription for the various outputs cannot always be allocated in a definitive way.

Applied economic analysis cannot by itself define management direction because of its inability to precisely measure non-market benefits. Enhancement of esthetics, wildlife, recreation, and environmental protection are areas difficult, if not impossible, to measure in economic terms.

As a social science, economics can contribute to decisions once management direction is determined. Economic analysis is fundamental in identifying cost-effective ways to achieve objectives. Economics can also assist in estimating comparative benefits of multiple use. Estimates are required because of difficulties in projecting values which society may assign over the long term.

Economic analysis can estimate direct, indirect, and induced benefits of resource management decisions. Measurements can be compared to the weighting of values used in forest plans and environmental assessments to either support or refute judgments made by the Forest Service. While precise measurement of total benefits remains elusive, public awareness of economic analysis can assist in focusing constructive debate, in revealing areas of agreement and disagreement, and in reaching consensus on weighting and values. Understanding what is important to decisionmakers should help the public to determine how the Forest Service utilizes public input.

Recommendations

The Forests should inform the public of economic considerations in planning and decisionmaking.

The Forests should explain how relative weights are applied to decision factors, how they are derived, and what influence public expressions of forest values have in decisionmaking.

Local-State-Federal Coordination

> State and local governments should be given an effective role in federal agency land use planning (Public Land Review Commission 1970).

Concern about coordination is not new. The Forest Service Manual contains the following directive:

> Efficient management of the resources of the National Forest System results from planning that is thoroughly coordinated among all levels of government, including other federal agencies, State and local governments, and Indian tribes. Such coordination ensures that government objectives, policies, and programs for resource management are compatible to the extent possible. Therefore, the Forest Service will coordinate its national, regional, and forest planning with the equivalent and related planning efforts of the federal agencies, State and local governments, and Indian tribes (36 CFR Fig. 8(d), FSM 1920.73b).

Regional Foresters and Forest Supervisors of the study Forests meet annually with representatives of State agencies to discuss coordination. The Governor of Wyoming often participates in these discussions as do the state director and the district managers of the Bureau of Land Management (BLM), and superintendents of Yellowstone and Grand Teton National Parks. Forest Supervisors and District Rangers also meet annually, and often more frequently, with their local counterparts in federal and State agencies, county governments, and tribal councils. Representing the two Regional Foresters, the Supervisor of the Medicine Bow National Forest (headquartered in Laramie) has liaison responsibility with the State executive branch and other agencies. He also serves on the Wyoming State Forestry Advisory Committee which was established by the State Board of Land Commissioners in 1980 to guide development of a forest resource program for State and private forest lands and to advise on policy. The study team met with committee members in Pinedale and together toured timber harvest sites in the Upper Green River area.

Forest personnel comply with the National Environmental Policy Act and other federal directives by providing the State with opportunities to review environmental impact statements and by notifying the State of scheduled actions. Forest personnel have relied heavily on the State of Wyoming's Department of Economic Planning and Development, Department of Administration and

Fiscal Control, Institute for Policy Research, and Extension Service for current and projected population and economic data used for forest planning. Figures on forest-dependent industries such as recreation/tourism, outfitting and guide services, timber harvest, and forest product utilization are compiled by the Forests in cooperation with State and local agencies. The Wyoming Game and Fish Department has legal responsibility for managing wildlife on the Forests, and frequent consultations are held by State and Forest wildlife personnel.

The State of Wyoming and county commissions in areas which will be affected by forest projects should take part in planning strategies to involve the public. Under new planning regulations, the Governor may negotiate a memorandum of agreement covering planning actions such as policies and techniques for public participation, inventory and data collection, identification of issues, concerns, and management opportunities. A memorandum of agreement is a coordination vehicle which the Governor and Regional Foresters should consider implementing. The Forest Service and affected local governments should also pursue similar means of structuring coordination and sharing information.

Looking back, efforts by forest personnel to comply with coordination requirements appear good. Looking ahead, in view of Wyoming's projected growth in population and in resource development, is it good enough?

Recommendations

The Governor and Regional Foresters should explore, among other types of coordination, advantages of negotiating a memorandum of agreement on forest planning.

The Forests should explore ways to insure that local governments receive complete information and are consulted prior to proposed actions of local interest.

Practices: Innovation and Experience

In 1970, much of the public criticism heard by the team was about logging practices. Visible results of management actions, at that time, gave credence to public opinion that forest personnel were emphasizing timber production at the expense of other resource values. Critics argued that wildlife and scenic resources of northwestern Wyoming were nationally significant while timber was of local importance. Today as then, management must reflect the national importance of noncommodity values.

In 1982, the study team conducted field examinations to evaluate on-the-ground results of management practices. The demand made on each of the three Forests to produce a certain annual timber harvest apparently remains a central commitment with other endeavors subordinate. The team observed, though, that overall quality of management is superior to that observed in 1970. Timber harvest areas and accompanying roads are less obtrusive and better integrated with the landscape. Wildlife habitat, coordinated with the Wyoming Game and Fish Department, is receiving far more consideration than before. Regeneration of most old clearcuts is better than the team believed possible, though a few sites remain poorly stocked. On the three study Forests, silvicultural prescriptions for new timber harvests were generally for small clearcuts and shelterwood cuts with minimal visual impacts--an improvement over the large clearcuts observed in 1970.

But forest personnel cannot afford complacency. Inadequacies still exist in silvicultural prescriptions and on-the-ground application. Substantial budget reductions, anticipated by the Forests, may result in the loss of specialists who have made important contributions in recent years. In view of these circumstances, the Forests will be increasingly challenged to insure that all timber sales and associated actions represent quality forest management.

Figure 8. This large clear-cut was criticized as monotonous and devoid of interest in 1970. In 1982, reproduction had begun to soften the visual impact of of logging (Caribou Mesa, Bighorn).

1970

1982

Timber Harvesting

Public concerns of 12 years ago focused on size of clearcuts, lack of regeneration, and untidy appearance of clearcuts after logging. These issues have largely been resolved. In their place, the 1982 study team heard complaints of excessive extension of the road system and excessive harvesting programs--no longer the quality of the work but the quantity. Counterclaims were made by representatives of the timber industry and private citizens, as well, that the Forests had overreacted to the 1971 Wyoming Report and excessively reduced timber harvesting.

Concerns about large clearcuts, lack of regeneration, and visual degradation have been moderated by marked improvement in regeneration techniques. Regional Foresters and Forest Supervisors have directed personnel to plant trees on understocked clearcuts. Their resolve plus the know-how to do it correctly have contributed to success. Another factor has been time. Time has allowed some areas to heal from the visual impacts of the big clearcutting era in the 1960s. On many clearcuts, seedlings--inconspicuous and hidden by grass-forb mixtures in 1970--were in 1982 head-high or taller. The study team, recalling its own concern about the scarcity of regeneration on clearcuts 12 years earlier, was amazed to see the difference. ''Before and after'' photos for each of the Forests (Figures 8-11) will best illustrate. The overview look for 1982 was of old clearcuts, large and small, for the most part regenerated. Logging debris will soon be screened out by a canopy of young trees. Some freshly stocked clearcuts are now, or soon will be, dense enough to provide cover for big game.

Silviculture

Timber harvesting practices can be applied to forests and, under controlled conditions, simulate natural death and replacement of trees. Severe periodic losses of stands due to natural catastrophic events (fire, insects, and disease) can be moderated and harvested trees converted to usable wood products. The process is called silviculture. It is a technical specialty within forestry and has produced a specialized vocabulary. Table 3 presents a summary of silvicultural terms.

Technical terms can be confusing. The study team met with some inconsistencies in use of terms by forest personnel. For instance, partial cutting, sanitation cut, and salvage cut refer to harvesting techniques which may be used as part of a silvicultural system. They are not the names of separate systems, for these cuts do not necessarily provide for regeneration of the forest stand--a key element in a silvicultural system.

Two other terms, stocking and density, also need clarification. Stocking refers to the proportion of an area occupied by trees and is a measure of tree distribution. Density refers to the number of trees per unit area. A clearcut with a dense patch of regeneration in one part yields a high average density but poor stocking or distribution.

Confusion of terms has caused the Forest Service difficulty for many years. The agency recognizes the problem and has established a task force in the Washington Office. Results from the task force will be incorporated into new national planning directions. The Forest Service Timber Management Research staff is also incorporating standard terminology into the revision of Agricultural Handbook 445 (Burns, in press). In the meantime, silviculturists should insure that forest personnel use

Figure 9. The cutover look was especially severe at the skyline on this clearcut in 1970. In 1982, regeneration assures a new forest stand to alter the unnatural look of the harvested area (Cartridge Creek, Shoshone).

1970

1982

standard silvicultural terms in all reports, directions, and guidelines.

Silviculture demands a thorough knowledge of the biological requirements for establishment and subsequent growth of each forest tree species. In Wyoming, lodgepole pine is the major commercial tree species and the predominant natural species. Engelmann spruce and subalpine fir, less important commercially, grow on a good bit of forested land, and Douglas-fir, also a commercial species, occupies a smaller area. Aspen and limber pine, while of little commercial value in Wyoming, are important in environmental, landscape, and wildlife management.

Lodgepole pine grows almost everywhere throughout Wyoming's forest zone, between the upper and lower elevation limits for tree growth. The species is susceptible to attack by mountain pine beetle, and by

Figure 10. In 1970, the study team observed that esthetic qualities had been maintained by disposal of logging residue on this visually sensitive site. In 1982, reproduction was head high above the forbs and grasses that had hidden small trees in 1970. Conifers were beginning to replace aspen (Curtis Canyon, Bridger-Teton).

1970

1982

dwarfmistletoe and comandra rust diseases (Figures 12-14). Lodgepole pine thrives in full sunlight and is a pioneer species (the first to invade bare land).

Some lodgepole pine cones remain unopened on the trees. This characteristic, known as cone serotiny, may range from 0 to 85 percent in a stand and influences the choice of a silvicultural system for managing lodgepole pine. To assure successful regeneration, cone serotiny must be correctly estimated; proper harvesting methods selected; and suitable timing and methods of seedbed preparation used (Lotan and Perry, in press). Current guidelines concerning serotiny appear inadequate to assist silviculturists in the development of appropriate prescriptions. Experiment stations should refine regeneration harvest guidelines for stands with varying degrees of serotiny. Information is especially needed for the shelterwood and seed-tree systems.

Figure 11. This 1,200-acre clearcut was criticized by the study team in 1970 for size and lack of regeneration. During the 1960s, it was planted unsuccessfully several times. The last planting, in 1971, employed improved procedures. Regeneration is now considered a success (Sheridan Creek, Shoshone).

1970

1982

Table 3. Terms Used in Silviculture

Silviculture	Art and science of tending a stand of trees through its life cycle and of obtaining a replacement stand after harvest.
Certified Silviculturist	An experienced forester certified by the Forest Service as having completed a specially designed silvicultural training program. Six months of training at a university, intensive home study, and development of a silvicultural prescription for a given forest area are included.
Silvicultural System	A process whereby forests are tended, harvested, and replaced, resulting in a forest of a distinctive form. Systems are classified according to the method of felling of the mature crop with a view to regeneration and according to the type of forest thereby produced. Systems in common use include clearcutting, shelterwood, seed-tree, and selection.
Even-aged Management	The application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at maturity. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size and is harvested. Cutting methods producing even-aged stands are clearcutting, shelterwood, and seed-tree.
Clearcutting	The cutting method that describes the silvicultural system in which the old crop is cleared over a considerable area at one time. Regeneration then occurs from natural seeding from adjacent stands, seed contained in the slash or logging debris, advance growth, planting, or direct seeding.
Shelterwood	The cutting method that describes the silvicultural system in which, in order to provide a source of seed and/or protection for regeneration, the old crop (the shelterwood) is removed in two or more successive shelterwood cuttings. The first cutting is ordinarily the seed cutting, though it may be preceded by a preparatory cutting, and the last is the final cutting. Any intervening cutting is termed removal cutting.
Seed-tree	The cutting method that describes the silvicultural system in which the dominant feature is the removal of all trees in one cut except for a small number of seed bearers left singly or in small groups, usually 8 to 10 per acre. The seed trees generally are harvested when regeneration is established.
Advantages of Even-aged Management	Cutover areas receive full sunlight for some years after logging. These systems are well suited for shade-intolerant species that require full sunlight for successful germination and growth. Mature and over-mature trees are harvested and sound dead wood is salvaged in essentially one operation. Minimum road construction is required to harvest a given volume of timber. Heavy, dangerous concentrations of fuel can be sharply reduced or eliminated, reducing the threat of wildfire. Seedbeds can be easily scarified to promote natural regeneration or to be prepared for planting of seedlings. Overstory and understory trees infested with dwarfmistletoe are eliminated, leaving the cutover area free of the parasite. The shelterwood system is less disruptive of the natural landscape than clearcut or seed-tree systems. Mature shelterwood trees which are left after the initial cut, ameliorate the immediate visual impact of logging.

Disadvantages of Even-aged Management	Diversity of the new stands is minimal. Single species and single-aged stands may become vulnerable to the same insects, diseases, and parasites that affected the original stands. Natural advance regeneration of other species is generally eliminated, prolonging the ''cutover look.'' Elimination of advance regeneration also extends the time during which cutover areas do not provide cover for elk, a critical factor in Wyoming.
Uneven-aged Management:	The application of a combination of actions needed to simultaneously maintain continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.
Individual Single-tree Selection	The cutting method that describes that silvicultural system in which trees are removed individually, here and there, each year over an entire forest or stand. The resultant stand usually regenerates naturally and becomes all-aged.
Group Selection	The cutting method which describes the silvicultural system in which trees are removed periodically in small groups resulting in openings that do not exceed an acre or two in size. This leads to the formation of an uneven-aged stand in a mosaic of age-class groups within the same forest.
Advantages of Uneven-aged Management	The forest floor is relatively undisturbed and sheltered by remaining trees. These systems are well suited for shade-tolerant species that germinate and grow in the absence of full sunlight. Advance regeneration is promoted, reducing the need to plant seedlings and the cost of regeneration. A forest cover is maintained at all times protecting esthetic qualities of the harvest area. Some wildlife cover is maintained continually.

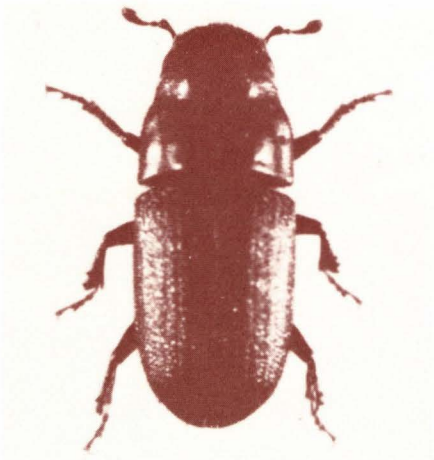


Figure 12. Mountain pine beetle (above) is a serious pest in Wyoming forests. As an infestation increases, entire stands may be killed.

Disadvantages of Uneven-aged Management	Frequent entries into the stand are required during the rotation period.
	More road construction is needed to harvest a given volume of timber than in even-aged systems.
	Scarification of seedbeds is difficult.
	Fuel loads in the understory are difficult to reduce or eliminate. Regeneration of shade-intolerant species is discouraged.
Intermediate Cutting:	Removal of trees from a stand between establishment and harvest cuts. Thinning, clearing, liberation, improvement, and sometimes sanitation and salvage cuttings are included.
Thinning	A felling made in an immature stand primarily to maintain or accelerate diameter increment and also to improve the average form of the remaining trees without permanently breaking the canopy.
Salvage Cutting	The exploitation of dead, dying, or deteriorating trees--before their timber becomes worthless--because they are overmature or have been damaged by fire, wind, insects, fungi, or other injurious agents.
Sanitation Cutting	The removal of dead, damaged, or susceptible trees to prevent the the spread of pests or pathogens and promote forest hygiene.
Partial Cutting	Removal of part of a stand. A collective term which can refer to all cuttings other than clearcutting. It should not be used synonymously with selection systems.
Serotinous	A term applied to plant species or individuals that flower or fruit late in the season and to fruit or cones that remain on the tree without opening for one or more years (as the serotinous cones of jack pine, lodgepole pine, and the Ocala variety of sane pine).

Definitions are taken from *Terminology of Forest Science, Technology, Practice and Products* (Ford-Robertson 1971) and from information provided by the USDA Forest Service, Washington Office, 1982.

Figure 13. Dwarfmistletoe causes growth loss, deformity, and mortality in lodgepole pine stands particularly on the Shoshone and Bridger-Teton. The small flowering plant (above) is parasitic on branches and stems. Dwarfmistletoe control is a major factor in choosing silvicultural systems for these Forests.

Figure 14. The study team observed lodgepole pine trees killed by comandra rust. The rust fungus spends part of its life on comandra, a herbaceous plant, and part on lodgepole pine. It presents a serious management problem on the Shoshone and Bridger-Teton.

Lodgepole pine, in natural forest succession, would eventually be replaced by Engelmann spruce and subalpine fir at higher elevations and by Douglas-fir on lower, drier sites--if fire or other major catastrophic disturbances did not intervene. In the absence of management, lodgepole-dominated forests in Wyoming follow a cycle of 150 years or more. After about the 80th year, lodgepole pine becomes increasingly susceptible to mountain pine beetle, comandra rust, and dwarfmistletoe. Trees weaken, die, and fall. Because decay is very slow, fuel loads build up continuously. On some sites, subalpine fir and spruce seed in. On other sites lodgepole is the only tree species present. Eventually fire occurs, either as a creeping ground fire in the down timber or as a crown fire if weather conditions are right and enough live trees are still present. Studies of fire-scarred trees on the Bridger-Teton confirm that past wildfires were widespread with peak frequencies in the 1840s and 1880s (Gruell 1980a,b).

Engelmann spruce and subalpine fir frequently grow in mixture at higher elevations. Both spruce and fir are shade-tolerant and can reproduce successfully under their own shade or that of a lodgepole pine stand. In Wyoming, Engelmann spruce and subalpine fir occur in both even-aged and uneven-aged stands offering flexibility in choice of silvicultural systems. But the choice is difficult. Most spruce-fir stands on the study Forests are mature or overmature and offer limited opportunity for single-tree or group selection because of slow growth and susceptibility to blowdown. Clearcutting has been used, but frequently presented regeneration problems which can

Figure 15. Proper timing and sequence of silvicultural practices, good sales administration, and follow-up help assure successful regeneration (Grizzly Sale, Bridger-Teton).

now be reduced by application of proper silvicultural prescriptions (Alexander and Edminister 1980).

Douglas-fir occurs in limited acreages at lower elevations and on warmer, drier sites of the forest zone. Although not harvested in large volumes, this species is important because of its special growth requirements. It is a species silviculturists can mix with lodgepole pine on warmer sites as a hedge against damaging insects and diseases. Douglas-fir thrives in full sunlight, except on dry south-facing slopes where some overhead shade is beneficial during early years of stand establishment. Extreme care must be exercised in the harvest and regeneration of existing Douglas-fir stands in Wyoming. If regeneration and establishment requirements are not met, it is likely no other commerical tree species will occupy the site for decades.

The 1971 Wyoming Report recommended that timber sales include silvicultural prescriptions developed by qualified silviculturists. Each of the study Forests has developed what appears to be an acceptable level of technical competence in the practice of silviculture. Both Regions are participating in an academic program to provide certified silvicultural training. The Bridger-Teton has at least one certified silviculturist in the Supervisor's Office and on each district. The Shoshone and Bighorn have assigned these positions to the Supervisor's Office.

Observations by the study team and contacts with silviculturists raised some questions about silvicultural prescriptions. The full range of prescriptions is not being used on any of the three Forests. The Bridger-Teton writes essentially one prescription for most timber stands--clearcut, pile and burn slash, and then plant to lodgepole. Little or no reliance is placed on natural regeneration and any that occurs is considered ''gravy''. The Shoshone and Bighorn, by contrast, base their prescriptions on partial cuts of the overstory, minimum slash disposal, and dependence on advance reproduction and natural seeding for regeneration. Plantings are limited to special situations or made only as a last resort.

Silviculturists offered valid reasons for the limited range of prescriptions being used. Factors included physiological condition of forest stands, ecological requirements of tree species for regeneration and growth, calculated risks of loss by fire, and allayment of public fears about regeneration failures. Silviculturists must also meet management objectives for the forest stand, be they wood production, watershed protection, wildlife habitat enhancement, esthetics, or more likely, a combination of these.

Figure 16. Improper synchronization of practices and poor follow-up can lead to regeneration failures even on productive sites (Terrible Basin Sale, Bridger-Teton).

Prescriptions used have, for the most part, been successful in recent years (Figures 15 and 16). The team's concern is that, even though the level of technical competence is adequate, ecological information is not being used to full advantage. The study team saw a need on all three Forests for silvicultural prescriptions written to maintain the forest diversity required for wildlife habitat, landscape design, and recreational use. Certified silviculturists, wildlife biologists, landscape architects, and recreation specialists should work together in describing stand conditions and development patterns. Experiment stations and other researchers should develop guidelines for achieving species mixture in lodgepole-dominated stands. Where pure lodgepole stands are the objective, stocking and thinning guidelines are needed to enhance both wood production and wildlife cover.

1970

1982

Figure 17. Habitat type data can predict regeneration problems such as shown on this tension-zone harvesting site (Copper Creek, Bighorn). In 1970, meadow grasses and forbs had replaced forest understory plants. In 1982, regeneration was abundant near the remaining forest (background) and sparse near the grassland.

Wyoming's forests are quite forgiving. Trees will come back no matter what is done, if the land manager is willing to wait. The waiting period may be undesirably long, especially on tension zones where forests and grasslands come together. Clearcuts made in the 1960s at Copper Creek (Bighorn), Wiggins Fork (Shoshone), and Baldy Mountain-A Sale (Bridger-Teton) are examples (Figures 17-19). These sites remain understocked.

The questions arise, should the land manager wait 15 to 20 years to get adequate regeneration on tension zone sites? Or should the cycle be speeded by planting? Answers depend in large part upon economics and the willingness of the Forest Service to shoulder public criticism about apparent lack of concern for cutover areas without regeneration over long periods of time.

1970

1982

Figure 18. These large clearcuts made in the 1960s extended from the forest zone in the background through the tension zone in the foreground. In 1970, regeneration was not evident. In 1982, regeneration is apparent in the forest zone but sparse and patchy in the tension zone (Wiggins Fork, Shoshone).

Figure 19. This dry site was harvested to the adjacent grassland in 1966. Sixteen years later, regeneration is still inadequate (Baldy Mountain, Bridger-Teton).

Use of ecological information--data about the interrelationships of soil, climate, and plants--can predict difficulties in regeneration and contribute to the design of appropriate silvicultural prescriptions. Such data should help the silviculturist decide where and when to depend upon planting rather than natural regeneration to obtain reforestation in a reasonable length of time--5 years. It should also indicate which silvicultural systems or cutting methods can be used to maintain or create uneven-aged, mixed-species stands that will be less vulnerable to catastrophic insect or disease attacks than single species even-aged stands.

The 1971 Wyoming Report recommended that experiment stations develop habitat type classifications and provide ecological information useful in the management of forest tree species. Habitat type classifications have been developed and made available to the Forests by the Intermountain and Rocky Mountain Forest and Range Experiment Stations (Hoffman and Alexander 1976 and Steele et al. 1979).

For most effective use, though, habitat types must be recognized and mapped. The Bridger-Teton has mapped some 600,000 acres or about 63 percent of the regulated commercial forest land on the Forest. The Shoshone has mapped a smaller proportion, while the Bighorn has reported no mapping to date.

After identification and mapping, relationships and correlations must be recognized for each habitat type. They must be interpreted to help develop appropriate silvicultural practices to meet the needs of all forest resources while providing for regeneration, growth, and vigor of the trees. Research promises additional information, but the bulk of local ecological relationships will have to be determined by forest specialists on the scene. No one is better qualified to do the job. Silviculturists, ecologists, biologists, hydrologists, soil scientists, and other specialists should be encouraged to record their observations and judgments. Initial conclusions will be tentative but can be refined and strengthened as additional information is gathered. Otherwise, local knowledge and experience will be lost to the Forests as specialists transfer or retire. Replacements may be well-trained academically, but the knowledge or ''feel'' for local situations is best gained through on-the-ground experience. It should not be lost. This situation is not unique to the study Forests, but exists throughout the Forest Service. Research should support administrators in developing systematic records of specialists' observations and conclusions about habitat types.

Proposed Harvesting in Unroaded Areas

The issue of whether or not to extend timber harvesting into presently unroaded areas was raised repeatedly in public group discussions. The study team heard comments which suggested contrasting concerns: wildlife habitat and pristine conditions, on one hand, and timber supply and health of the forest, on the other.

Unroaded areas of old-growth forest offer a quality environment for outdoor recreation--an environment good for the outfitting business. Elk hunting occupies a considerable portion of that business and provides income to the community and to the Wyoming Game and Fish Department which manages hunting seasons. Hunting is also the primary technique available to the State for regulating population structure and numbers of animals. At the same time, harvesting overmature stands of timber is recognized as the best means for maintaining a vigorous forest, while also generating income in the timber industry and the community.

The issue of roads vs. no roads eliminates middle ground for compromise. Until forest plans determine which areas will be roaded and where and how timber will be harvested, resolution can best be achieved through case by case application of the environmental assessment (EA) process. Prior to decisionmaking on a proposed timber sale, the Forests prepare an EA to weigh timber utilization along with other resource management objectives. The study team reviewed several EAs on timber sales in previously unroaded areas.

The three Forests appeared to follow a consistent pattern in preparing these reports. Proposed sites were usually selected because of standing timber volume and nearby roads. A timber management specialist served as head of the interdisciplinary team assigned to the task. Public input was considered in identifying potential multiple-use conflicts and in formulating alternatives. Moderate alternatives were usually selected for unroaded areas and timber harvesting plans included common elements :

Scheduling harvest activities for the least disturbance to wildlife, particularly elk;

Planning 15-year intervals between harvest entries;

Using landscape architects and wildlife biologists to help design and locate roads and harvest areas;

Closing roads after harvesting activities have been completed;

Preparing detailed silvicultural prescriptions;

Compressing logging contractors' time to no more than what is needed to meet performance requirements; and

Conforming to requirements of all forest plans, regional directives, and national policies.

Following approval of the EA, timber sales require further field work and preparation of site plans and sale documents. At this point, planning oversights can be corrected on the ground, and harvesting decisions beneficial to resources other than timber assured. For example, individual snags and nesting trees can be marked for retention and existing second-growth wildlife cover patches protected. The study team believes that forest specialists should be involved in the timber marking

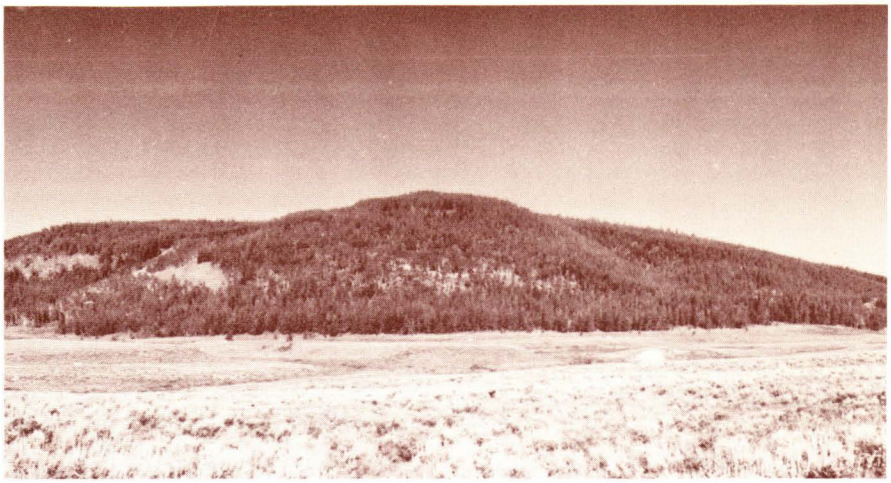


Figure 20. Proposed timber harvesting in portions of the unroaded Klondike Hill area (Bridger-Teton) has caused intense public reaction. The Forest Supervisor, working with a local consensus group, heard arguments for and against the sale before proceeding with the proposal. Opponents of the sale have appealed the decision.

process and in monitoring other timber activities to reduce the risk of inadvertent mistakes or oversights.

The recent history of accomplishment by the Forests, though tarnished by a few lapses, has raised public expectations for professional performance. The decision to proceed with any timber sale, but especially with a controversial sale in a previously unroaded area (Figure 20) must be supported with the strongest commitment for on-the-ground accomplishment of stated objectives.

Rate of Harvest

The perception of excessive harvesting is easy to understand when viewing certain parts of the three Forests from the air (Figure 21). It may appear to many that in some areas not nearly enough forested land remains to sustain the existing harvesting program for the completion of the first rotation, some 100 years from now.

The public issue of overharvesting is not directed toward the Forests as a whole but rather to that portion of the total acreage allocated for commercial harvests.

Commercial lands may be regulated or unregulated. Regulated lands are managed for timber production under sustained yield principles and are divided into three categories:

1. Standard. Crops of industrial wood can be grown and harvested with adequate protection of forest resources under usual provisions of timber sale contracts.
2. Special. Specially designed silvicultural treatment of the timber resource is needed to achieve landscape and other resource objectives.
3. Marginal. These forest lands do not qualify as standard or special because of excessive development cost, low product value, or resource protection constraints.

The study Forests are now harvesting primarily from standard and special components of regulated commercial forest land. The proportion of these lands to total acreage is 34 percent on the Bighorn, 3 percent on the Shoshone, and 12 percent on the Bridger-Teton (Table 4). If marginal lands were included, the proportion would increase to 43 percent on the Bighorn, 4 percent on the Shoshone, and 28 percent on the Bridger-Teton. Most of the non-commercial forest land on these Forests is classified as wilderness but other categories such as inoperable, scenic, recreation, roadside zone, and others add to the acreage.

Figure 21. This aerial view, observed during the team's flyover examination in July 1982, illustrates the concentration of timber harvesting sites that conveys the impression of overharvesting (Wyoming Range, Bridger-Teton).

The team's analysis of harvest schedules on each Forest shows some situations that bear further attention (USDA 1975, 1979 b and c). For example, the Bridger-Teton is harvesting 29 million board feet of timber annually from standard and special commercial forest lands for the current planning period. The potential yield, for the standard and special lands for the same planning period is 21 and 30 million board feet per year respectively (Table 4). At first glance, ample volume would appear to exist for harvesting. However, potential yield--a term that connotes all that the land can produce--is not treated as a rigid criterion. For example, within allowable limits the Bridger-Teton adjusted downward the potential yield of the special component of commercial forest land from 30 MM bd. ft. to 8 MM bd. ft. to accommodate landscape and other resource management objectives for the current planning period. This reduction then established harvesting at about 100 percent of potential yield instead of the substantial underharvest as the team first thought (the planned harvest of 29 MM bd. ft. is 100 percent of potential 21 + 8 MM bd. ft.). The 22 million board feet reduction in potential yield on the special lands provides a safe margin for error if it is freely available for harvest during the planning period. If not available, the volume, in effect, has been transferred to the marginal component. Then there is no safety cushion and the Forest is cutting to the maximum of potential yield.

Marginal lands could provide additional harvest volumes. On the Bridger-Teton these lands, which have an annual potential yield of 66 million board feet, are not included for harvest in the current planning period.

A somewhat similar situation exists on the Shoshone and Bighorn in terms of current harvest or percent of potential yield--50 percent and 41 percent respectively. But there are differences. On the Shoshone, the harvest figure applies forestwide, and may not necessarily reflect favorable timber supply situations in some localities. This forest has a heavy concentration of past timber harvesting on the Wind River District. Present timber harvesting is low, but the concentration of timber industry at the neighboring town of Dubois creates a pressure for continual cutting in the convenient nearby forest lands. This pressure has been resisted recently as can be attested to by the very low annual harvest programmed for the current planning period. Allocating more of the allowable harvest to other districts may not be a viable alternative. The timber on other districts is generally of lower quality, and the long-hauling distances make this alternative economically unattractive.

Table 4. Potential Yield and Programmed Annual Timber Harvest on the Bighorn, Shoshone, and Bridger-Teton National Forests, 1981-1991

Land classification by National Forest	Land area		Potential yield	Volume cut	
	Thousand acres	Percent of forest	million board feet	Million board feet	Percent potential yield:standard plus special
Bighorn					
Total area	1,107	100			
Standard	191	17	9		
Special	188	17	13		
Marginal	92	8	17		
Total regulated	471	43	39	9	41
Shoshone					
Total area	2,432	100			
Standard	64	3	7		
Special	5	T*	1		
Marginal	25	1	2		
Total regulated	94	4	10	4	50
Bridger-Teton					
Total area	3,400	100			
Standard	182	5	21		
Special	252	7	30		
Marginal	523	15	66		
Total regulated	957	28	117	30	59

Source: Figures were obtained from timber management plans for each Forest and adjusted or updated in consultation with timber resource staff at headquarters of Regions 2 & 4.
*Less than 0.5 percent.

Timber harvesting on the Bighorn is at a relatively low level. Forest personnel reported that this situation resulted from closure of large acreages of land to timber harvesting in the 1970s due to the RARE process and from lack of adequate funding for road building into unroaded areas. Consequently, recent harvesting has been concentrated in areas already accessible and has been frequently targeted to stands of timber adjacent to earlier clearcuts. This activity has caused an adverse impact where recent harvests were made before regeneration on adjacent clearcuts was complete or tall enough to provide adequate wildlife cover. Even though the activity level of timber harvesting is relatively low, serious consequences may occur within an area of concentrated clearcuts.

This analysis of the rate of timber harvesting may put to rest some of the concern about overharvesting, but an uneasiness lingers. The interpretation of the term, potential yield varies among Forests. The Forest Service Manual definition for potential yield is the harvest that could be planned on commercial forest land considering the productivity of the land, conventional logging technology, standard cultural treatments, anticipated financing for cultural treatments, and relationships with other resource uses and the environment. The definition includes sound, dead trees. The Bridger-Teton uses the Manual definition, but modifies its use as situations dictate. The Bighorn also uses the Manual definition but interprets it to mean ''maximum harvest needed'' rather than ''could be planned'' to achieve the optimum sustained yield under intensive forestry on regulated commercial forest land. The Shoshone interprets potential yield as, ''...the sustained production the timber resource can support under

intensive management...'' However unlikely, if the Bridger-Teton applied the Shoshone interpretation to its standard and special lands, it would be dangerously overharvested. The Bridger-Teton does not implement the kind of intensive management inferred in the Shoshone definition.

Recognizing that potential yield is tailored by different sets of conditions among Forests, the flexibility in its interpretation and application creates a dilemma. Is potential yield a control mechanism, or is it a term that sanctions manipulation? Probably neither, but the lack of clarity in definition reduces confidence that its application will guarantee sound harvesting schedules.

Forest management terms such as standard, special, and marginal are currently under revision by the Forest Service. New terminology, projected for use in early 1983, will require close monitoring to assure correct interpretation.

The team believes that the Forests are harvesting timber at a rate that can be sustained under intensive management. Present allowable harvests should be substantiated to alleviate public concern about excessive timber harvesting. The team is seriously concerned about the heavy concentration of clearcuts in some areas where timber and other forest resources are being adversely affected. Left unresolved, these issues could weaken the credibility of forest personnel.

Recommendations

Forest personnel should use silvicultural terms consistently and according to standard definitions.

Research should develop guidelines for regeneration harvests in stands with varying degrees of serotiny.

Silviculturists should consult with wildlife, landscape, and recreation specialists to prepare silvicultural prescriptions designed to enhance non-commodity values.

Research should develop guidelines to achieve desirable species mixtures in lodgepole pine stands for wood production, wildlife habitat, and esthetic values.

Research should develop guidelines for stocking and thinning of lodgepole plantations to promote both wood production and big game cover as early as possible.

Recommendations

The Forests should use habitat type information in designing silvicultural prescriptions.

The Forests should develop a procedure for the systematic recording of local habitat type observations by specialists.

On all timber sales, but particularly on controversial sales in previously unroaded areas, the Forests must comply with environmental assessments to accomplish stated objectives on the ground.

The Forests should analyze definition, interpretation, and application of the term potential yield and develop terminology for common use.

The Forests should review timber harvest schedules and adjust if necessary to avoid creating critical timber supply situations on all components of regulated commercial lands.

Wildlife Habitat

In 1970, wildlife discussions in Wyoming most often referred to elk or fish. Today public concerns remain about the same, but within the Forest Service, wildlife has taken on a broader connotation. Elk still reign, but moose, grizzly bear, deer, and small bird populations now also receive consideration (Figure 22). In the 1971 report, the study team recommended that wildlife be recognized in management decisions but did not suggest specific methods. Usable habitat information for many wildlife species was not then readily available. Legal responsibility for wildlife management resides with the Wyoming Game and Fish Department, while habitat is managed by the Forest Service. Consideration of habitat quality as a determinant of wildlife populations has now been codified in law (RPA 1974 and NFMA 1976). During the past 5 years, wildlife-information data base programs for quick access by computer have been compiled and specific evaluation techniques have been developed for elk habitat, snags, and a few other specialized habitats (Thomas 1979).

Figure 22. A bull moose browses near security cover (Shoshone). The Forest Service includes moose and other major wildlife species in management plans.

While limited, these programs can be helpful in assuring recognition of potential wildlife habitat problems.

Assignment of wildlife biologists has been in response to mandates of recent federal legislation. Staff increases indicate that wildlife is being recognized on the Forests in Wyoming, but statistics alone cannot answer the larger question of performance on the ground. The public is concerned, as in 1970, that plans be explained and that results meet expectations. Just mentioning wildlife cover and foraging areas in environmental assessments or leaving snags for nongame wildlife is not enough. On-the-ground evidence must confirm that wildlife habitat quality has not been sacrificed for the short term and that substantial improvement in habitat can be expected over the long term.

The public issue of wildlife resources in Wyoming, rather than diminishing, has expanded and diversified. In public meetings, some discussions centered on habitat quality and roads and their effects on hunting and recreation. Timber programs were not considered totally detrimental to wildlife, but divergent opinions were heard about habitat improvement. At one extreme, unroaded forest was presented as a last stronghold of security for big game. At the other, undeveloped forest was represented as a wasteland of dead and dying trees, a potential fire hazard, useless as wildlife habitat.

Wildlife and Timber Harvesting

The 1982 study team reviewed ways in which wildlife habitat might be enhanced by timber harvesting. Were benefits ascribed to harvesting real or simply justifications for cutting timber? In addition to field observations, the team interviewed Forest Service and Wyoming Game and Fish Department personnel.

On several occasions, timber specialists pointed out jungles of downfall as examples of marginal wildlife habitat to be improved by cutting. Forage growth in clearcuts and resprouting of cutover aspen were represented as beneficial to wildlife (Figure 23). Regenerated young lodgepole stands were noted as good wildlife hiding cover with far shorter viewing distances than adjacent uncut forest.

Taken in isolation, each of these observations is provable fact, but few wildlife species are capable of existing in habitats of isolated bits and pieces. Most downfall areas did have some usable passage ways, provided security, and in a few cases, represented the only wildlife cover available. Generally, forage shortage was not a problem, and forage without adjacent cover may not be available to wildlife. Thinning was often undertaken precisely when the young stands had begun to provide hiding cover for wildlife.

Some timber management specialists tend to view each stand as an isolated problem to be rectified for future timber production. Enhancement of wildlife habitat quality is a probable, but not certain, concurrent result. The opportunity for habitat improvement through silviculture is highest in areas which lack natural openings and lowest in areas where timber occurs in isolated stands. Opportunities for habitat improvement may be limited at the time of second-entry timber harvesting.

Each of the three study Forests has a wildlife staff specialist in the Supervisor's Office and at least one biologist on a ranger district. The Bridger-Teton has biologists on every district. The senior biologist on each Forest has been assigned to the forest planning team. Involvement of these biologists in planning has altered

Figure 23. On this hillside, a stand of mature aspen was felled to promote root sprouting. The resultant dense stand of young aspen with foliage close to the ground increases the browse for big game (Long Creek, Shoshone).

the ''certainty'' once held by timber specialists that timber sales enhance wildlife habitat. Planning requires long-range evaluation of continuing management and cumulative effects. As a result, biologists and others on the planning team have become acutely aware of the need to maintain balance between cover and forage, to assure juxtaposition of forest types, and to achieve simultaneous recognition of wildlife species. Optimum habitat for wildlife species can be described in management prescriptions, but no such prescriptions have been developed, adequately tested, or published for Wyoming wildlife species.

An example of potential cumulative effects of timber harvesting was pointed out by the Shoshone Supervisor during the study team's tour of the Wind River District. Here each timber sale along the elk migration route from the Washakie Wilderness to the winter range north of the Wind River was designed to assure adequate hiding cover. But unless the total area, including relationships between cutting units in adjacent sales, is considered, cumulative influence on elk may not be desirable.

To determine State and Forest Service coordination, telephone contact was made with Wyoming Game and Fish Department biologists and district administrators in Jackson, Smoot, Pinedale, Cody, Lander, and Sheridan--towns which border the study Forests. Department personnel reported direct involvement in national forest timber management decisions. They stated that all three Forests showed concern that elk calving and security areas and migration routes were recognized and that decisions and actions on the ground were acceptable to the State. Proposed timber management in unroaded areas in the upper Green River drainage (Bridger-Teton) and the proposed Dunoir addition to the Washakie Wilderness (Shoshone) were being challenged by the Wyoming Game and Fish Department, but considering the potential

for conflict between big game and timber management, Forest Service personnel deserve credit for existing coordination and cooperation.

Despite disagreement concerning results of past timber harvesting, State and Forest Service biologists concur that harvesting can be used in certain situations to enhance wildlife habitat in Wyoming. The study team's impression was that this potential is not being exploited by the Forests. Some predictions of wildlife habitat improvement appeared to have been used to justify timber harvest in areas perhaps better left uncut.

Even though an adequate level of silvicultural competence is available, technical expertise is not always being utilized to benefit wildlife. From a wildlife habitat standpoint, the current trend on the Forests toward stand homogeneity is undesirable. Near Beaver Creek (Bridger-Teton), the study team was shown several young lodgepole pine stands created by past clearcutting and planting. Between these stands, leave strips containing Engelmann spruce, subalpine fir, and old lodgepole pine infected with dwarfmistletoe, were being considered for clearcutting and planting to lodgepole to protect the adjacent young pine stands. Removal of only the infected pine, leaving the spruce and fir as wildlife cover, was not contemplated because spruce and fir have little commercial value compared to pine.

Cutting units on all three Forests demonstrate that variations in stand structure and composition can be achieved by silvicultural prescription. The ability of

Figure 24. A vigorous young lodgepole pine stand, thinned to promote wood production, limits protective cover for big game. Thinning to a variable density or leaving clumps of heavy cover would be preferable where wildlife is a major consideration (Buffalo District, Bighorn).

the silviculturist to recognize potential variations--and the ability of other specialists, particularly wildlife biologists, to specify desired combinations--should not be constrained. In a few situations, the preponderance of lodgepole pine may limit diversity, but this should merely provide impetus for innovation. Silvicultural prescriptions, rather than achieving a single purpose of increased timber production, should be designed to also increase forest diversity for wildlife habitat. Wyoming Forests, and the Bridger-Teton in particular, should take advantage of every opportunity to develop heterogeneity in stand structure and plant community composition.

The narrow range of silvicultural options being used on the study Forests is further constricted by standardized thinning. Timber stand thinning policies should be evaluated on all three Forests. Long stretches of open-stand lodgepole pine, as on Highway 16 (Bighorn), may promote growth of timber but add little interest to roadside landscape and limit wildlife movement adjacent to or across roads (Figure 24). The team questions whether reductions below 600 stems per acre are necessary when wildlife is a consideration. On the Bridger-Teton and Shoshone, young lodgepole pine stands were being thinned just when they had begun to provide cover for wildlife (Figure 25 a & b). Timber stand improvement is desirable where adequate wildlife cover exists or where sawlog production is the only management objective. In Wyoming, wildlife is a priority. Stand diversity and big game cover should at least share the status of wood production.

a

b

Figure 25. The study team compared (a) a lodgepole pine plantation just beginning to provide security cover for big game (Copper Creek, Bighorn) with (b) a 10-year-old plantation just thinned to promote growth (Flattop Sale, Bridger-Teton). Standard thinning of young stands postpones the time when adequate wildlife cover can be provided.

Wildlife Biologists

The study team addressed these questions: What function does the wildlife biologist serve on the Forests? What is the nature of the biologist's input, and are results evident on the ground? Conversations on these points were held with staff officers and wildlife biologists, and environmental assessment documents were examined. The study team was concerned that few of the senior specialists were members of professional societies. While membership in a professional organization is not prerequisite to professional performance, it does facilitate maintaining contacts with others in the field.

On all three Forests, wildlife biologists were assigned to the planning team. Shoshone and Bighorn biologists appeared to also have substantial assignments in range analysis. While planning and range analysis are essential jobs, time spent on non-wildlife assignments limits in-depth wildlife evaluation by the biologists. The Forests apparently do not view these assignments as a conflict. The biologist on the Bighorn has supplied input to all environmental assessments written for timber sales in the last 2 years despite his planning-team assignment, but he has not participated in a field evaluation during that time. On this Forest, Ranger District personnel with some wildlife training are handling less technical wildlife problems. Dilution of wildlife assignments is of concern to the study team. In view of potential impacts of timber harvesting and roads upon wildlife, the team believes that part-time wildlife assignment will not provide the expertise required where wildlife should be a major consideration.

Technical Information

As new forest plans are completed, greater participation by senior biologists in on-the-ground wildlife projects will become possible. If increased participation is to produce quality results, information not currently available will be needed. All three Forests utilize Agriculture Handbook 553 (Thomas, editor 1979) and its comprehensive table of habitat needs. Both Regions have large computer-accessible data-bases available. Wildlife biologists should translate this information into direct and positive management procedures. Forest personnel may be reluctant to use information bases until wildlife goals are better defined in new forest plans. The Wyoming Game and Fish Department has a long-range wildlife strategic management plan which can assist in defining forest wildlife goals.

The Bridger-Teton has developed a comprehensive evaluation system for elk habitat (USDA Forest Service Bridger-Teton National Forest 1979a) and all three Forests use snag management guides. An environmental assessment report from the Shoshone contained slash management directives clearly designed to enhance small mammal habitat in support of raptor populations. Similar comprehensive habitat designs are needed for deer, moose, and small birds in Wyoming. Situations in which maintenance of elk habitat quality will be inadequate for other big game species must be detected. A better job could be done if specific habitat evaluation guides were available for at least the major wildlife species and groups.

Environmental assessments examined by the study team did not usually contain adequate presale wildlife inventory information--either of habitat or animal populations. If standardized and efficient inventory techniques were developed by the Forest Service and the State, plans to benefit wildlife could be facilitated and

post-sale monitoring would become more meaningful. The forest biologist on the Bridger-Teton has initiated a study to assist in evaluating big game cover, but the need is far greater than can reasonably be solved by independent studies at the forest level.

Roading Influences

During the past 10 years, research throughout the Rocky Mountain West has documented incomplete utilization of elk habitat adjacent to forest roads (Ward 1976, Rost and Bailey 1979). In Washington, Perry and Overly (1976) have shown that the avoidance response is greatest near primary roads and least near jeep trails. Lyon (1979) found that heavy cover reduced the effect but even in good hiding cover, elk use of habitat within 300 yards of a road was significantly less than elk use at greater distances. Reductions in habitat use of 25 percent or more have been estimated wherever road densities exceed one mile per section (Thomas et al. 1979). Clearly a proliferation of forest roads will be detrimental to elk unless management also includes a successful program of road closures.

Another area of concern, mentioned most often by Wyoming Game and Fish Department personnel, relates logging and road access to management of the hunting season. In forested big game habitat a properly managed timber harvest can be expected to increase forage production in the short term and provide better cover and greater diversity in the long term. Potentially, a managed habitat will support greater numbers of animals. At the same time, timber harvesting provides access for hunters and reduces security offered wildlife by unroaded, undisturbed forested areas. Even if roads are closed to motor vehicles, hunter access is easier than in unroaded areas. The number of hunters present is likely to be higher. The number of elk killed per hour of hunting is likely to increase, and the number of hunter days required to obtain the desired harvest is likely to decrease. The net result is that hunting seasons must become shorter, or numbers of hunters must be reduced by limiting licenses (Lonner and Cada 1982). This is a significant relationship because game departments are supported by license sales, and the desirability of their product is greatly enhanced by longer hunting seasons. Economic benefits to local communities are also related to the length of the season and the number of hunters. Any management decision to maintain longer hunting seasons will require an adequate road management program.

Results of research on road design and location in elk summer range in Montana (Lyon 1975, 1980) and in Idaho (Hershey and Leege 1976) suggest the lowest road standard adequate for the job and road locations which avoid movement corridors and other areas important to elk. Timber sale areas should be laid out to reduce disturbance and provide adequate nearby security, and roads should be closed in every situation not absolutely needed for management.

The study team saw evidence that the three study Forests are aware of these findings. New roads are exemplary in terms of design and standard, but road locations are perhaps less sensitive to situations important for wildlife. Several timber sale environmental assessments reviewed by the team did suggest relocation of roads. Suggestions by Wyoming Game and Fish Department biologists concerning movement corridors and cover were included in these analyses. Security, especially for elk calving areas, often resulted in specifications concerning time periods during which logging roads must be closed.

In Wyoming, as elsewhere, any habitat improvement obtained through timber harvesting can be lost because of roads. Many of the public concerns reported in 1970 could be traced to silvicultural decisions made without adequate silvicultural expertise. The Forests have corrected this deficiency and should now make every effort to avoid repetition in other specialties.

Recommendations

Timber stand improvement thinnings should be designed to meet wildlife cover and landscape design requirements.

The Forests and Regions should make a concerted attempt to maintain full-time assignments in wildlife positions.

Regional offices should consult with forest biologists and develop procedures through which existing data-base programs can be more fully utilized in management.

Research should be encouraged to develop specific habitat prescriptions for deer, moose, and small birds in Wyoming forests.

Forest Service research and the State of Wyoming should be encouraged to assist the Forests in developing sampling systems adequate for inventory and monitoring of wildlife habitat and populations.

The Forests should coordinate seasonal road-closure programs with wildlife management goals of the Wyoming Game and Fish Department.

Road-closure programs should be vigorously pursued in all situations where open forest roads significantly reduce habitat effectiveness for elk.

At the consensus group meeting in Pinedale, the study team met residents seeking, among other resource considerations, ''conservation of the things we see.'' At Dubois, one of the local dude ranch owners pleaded for ''a last opportunity to save a little bit of wild country.'' Community meetings aired current public issues surrounding visual effects of forest management on the landscape (Figures 26 and 27). Residents and visitors expressed concern for preservation of native Rocky Mountain landscapes.

1970

1982

Figure 26. These harvest areas were commended in the 1971 report for building on natural landscape patterns. Subsequent cuttings have maintained the natural appearance of the landscape (Mt. Leidy, Bridger-Teton).

Visual Management System

In 1970, the study team recommended a means to recognize landscape as a visual resource and to document visual values. Landscape architects began to be assigned to the three Forests in 1971. In 1974, the Forest Service issued the Visual Management System (VMS), a national forest landscape management planning procedure. The system provides for landscape inventories, sensitivity ratings, and visual quality objectives. The question facing the study team in 1982 concerned whether landscape conservation had been successfully integrated into forest management.

Landscape inventories identifying visual quality objectives have now been completed for the three Forests. During the past 2 years, landscape architects have used this material in developing forest plans. They are also training forest staffs of varied disciplines to understand the system and its use in interdisciplinary planning. VMS

1970

1982

Figure 27. In 1970, the study team cited this area for unsightly residue left after logging and for removal of the tree cover around the pond. In 1982, only a scattering of small trees can be seen and logging debris is still evident. Natural restoration of the landscape will require at least another decade (Union Pass, Bridger-Teton).

establishes priorities for a Forest in controlling visual impacts of resource manipulation.

Variety classes designate landscapes of three scenic qualities--distinctive, common, and minimal--and are determined from maps, photography, and field reconnaissance. For the study Forests, the classes are evaluated within the characteristics of the Middle Rocky Mountains landscape. Sensitivity levels are defined as public concern for scenic quality. Determining such concern by direct means is impossible. Landscape architects substitute use estimates such as traffic counts on federal highways versus those on local roads. Both variety classes and sensitivity levels are mapped for visibility within several distance zones. Visual quality objectives controlling degrees of visual change, are then designated upon previously mapped areas. The Bridger-Teton staff has developed an interpretative guide and training booklet on using the system (USDA Forest Service, Bridger-Teton National Forest 1980). Similar material would be desirable on the other two Forests.

VMS is a planning tool subject to improvement by professional use. It should not be considered a static device. Landscape architects should interpret procedures where necessary in the field, applying professional judgment beyond the scope of VMS. Boundary areas of the Teton and Bridger wilderness provide good examples. Here visual quality objectives call for ''retention'' or ''partial retention'' at some points using manipulations which would be unobtrusive, subordinate to the natural landscape, and appropriate adjacent to wilderness. At other points, ''modification'' or ''maximum modification'' would allow manipulations apparent as man-made. These changes would dominate the scenery, even with designs borrowed from native landscape. Such objectives adjacent to wilderness appear inappropriate since wilderness is defined by naturalness and absence of the works of man. The Jim Creek entry to the Bridger Wilderness presently carries a ''modification'' VQO. The 1971 Wyoming Report criticized this entry for its visual impact on recreational values. A more sensitive VQO here would be ''rehabilitation'', an area in need of visual repairs. Sympathetic transition between managed forest and wilderness would certainly decrease criticism by recreationists who travel through or view boundary areas.

All three Forests need to support general forest plans with improved landscape design layouts, on-the-ground advisory services, and monitoring. Few signs of on-the-ground advice by landscape architects and no evidence of landscape monitoring were seen by the team. In Wyoming with its concerned and vocal public, landscape monitoring of site specific manipulations (timber cutting, roads, silvicultural treatments) is essential. Monitoring is not a difficult task (Litton 1973) but landscape architects must be allowed the time for this activity.

The team observed evidence of planning and design sensitivity to visual values by forest personnel at the site level. Plans for the North Baldy Sale, off Highway 28 (Bridger-Teton), recognized the area as both an important elk migration and travel influence route. The scenic landscape along Blackrock Creek is the entry corridor to Grand Teton National Park, above Moran Junction. The study for the sale appeared to be a comprehensive blending of timber management, landscape design, and wildlife habitat. A series of visual prediction drawings based upon VIEWIT programs (Travis 1975) and computer-assisted graphics documented the plan. Several alternative schemes (cuts of 80 acres as opposed to 40 acres maximum) were proposed to satisfy visual layout and wildlife habitat requirements. Cutting

patterns and use of alternative size-shape relationships were carefully considered. Input from wildlife experts regarding values of the elk migration route was worked in well. The North Baldy Sale represents a proper extension of VMS planning into site-specific design. It is a model to be emulated--no other examples seen were up to its standard.

On all three study Forests, advice from landscape architects on designing timber cuts visually compatible with surroundings was sought during the environmental assessment process. To contribute to EA reports and facilitate visual interpretation of design plans, the landscape architect needs to be a student intimately familiar with the vegetation mosaic of the forest. The team studied environmental assessments for Jack Creek (Bridger-Teton) and timber sales reports for Tillet's Hole (Bighorn) and Cartridge Creek (Shoshone). These documents contained thoughtfully prepared landscape analyses but tended to cling closely to VMS language without presenting graphics to illustrate visual quality objectives. The influence of visual resources on management activities was stated only in abbreviated summaries. One example read, ''Under partial retention constraints, activities may be visible but must assume a natural character that harmonizes completely with the surroundings. Clearcutting must imitate the size, shape, and frequency of natural openings in the area to meet this objective.''

Visual prescriptions, in brief narrative report form without graphics, make direct interpretation difficult for forest personnel. Landscape architects are trained to prepare design representations through such means as sketches and plans. Table top computers can help assure accurate simulation graphics (Nickerson 1979). Helpful suggestions on graphic techniques for showing proposed cutting patterns can be found in ''Timber'' (USDA Forest Service 1980).

Acceptance of landscape architects appears positive, but their function will be improved with opportunities to go beyond general forest planning and preparation of EAs into more thorough site design work and on-the-ground advice. They need to be involved with routine detail support of resource management decisions as opposed to assignment only in crisis situations.

Diversity

Rocky Mountain landscapes, native to the three Forests, are proper models for maintaining visual diversity in management manipulations (Figure 28). Wildlife accommodation and landscape conservation both relate to the look of the whole forest. Diverse habitats for wildlife--dense cover, grassy openings, old growth, forest stands of different ages and structures, edges, and riparian vegetation--also provide a visually desirable variety in the landscape.

On Beaver Flat (Bridger-Teton), subalpine fir and lodgepole pine now dominate a tract that had been harvested for poles in 1964. Residual trees and natural regeneration in openings were characterized by the study team as good elk and moose habitat. Yet the area was described as nonproductive--no one would buy it as stumpage. Value for wildlife cover and landscape diversity was not considered.

Aspen is important to the landscape on all three Forests for the year-round color contrasts it brings to areas dominated by conifers. Aspen contributes visual enrichment for the recreationist as well as food and cover for wildlife. Management of aspen often involves temporary compromise between wildlife objectives and esthetic values. On two Long Creek sites (Shoshone), the team saw aspen stands clearcut to promote sprouting for

Figure 28. Unmerchantable subalpine fir was left after logging. Now it is intermingled with natural lodgepole pine reproduction, providing a diversity valuable esthetically and as big game cover (Antelope Mountain, Bridger-Teton).

elk browse. Nearby a pond retained aspen around it indicating that the scenic value of the species was recognized by forest personnel. Clearcutting results in aspen sprouting and will eventually (Figure 29) contribute to the esthetic quality of surrounding grassy hillsides. The team felt that aspen could receive more attention in management planning to enhance landscape values on the three study Forests.

On the Bridger-Teton, the new Pinyon Ridge clearcuts are typically small; the team observed one of about 8 acres. The sites are extremely rocky with natural openings. Layout of the cuts followed, to good advantage, natural openings which provided a transition to the edge. Residual trees forming the edge were spaced at variable distances and had full crowns typical of open-grown or exposed trees. The net effect makes a good visual relationship to the landscape--a relationship that cannot be achieved to the same degree with a cutting that passes through a dense stand with limb-free boles and high canopy.

Thinning techniques on regenerated stands could limit diversity retention on all three Forests. On the Bighorn, wildlife cover and visual contrasts should be considered in thinning young trees now started on old clearcuts. Nothing in Wyoming's rich vegetation mosiac suggests that the forest landscape will benefit if made to resemble pulp plantations of the South.

Visual impacts of thinning young stands are also showing up on the Bridger-Teton. The team visited a tract near the Moose Creek clearcut, where thinning to about 400 stems per acre had recently been completed on young

Figure 29. The scenic value of residual trees near this pond was recognized when an adjacent area was clearcut to stimulate aspen sprouting for elk browse (Long Creek, Shoshone).

lodgepole pine plantings. In the Spread Creek area (Lily Lake, Dry Lake plantings), thinning was planned. The visual quality objective was identified here as retention of native landscape characteristics. Standard thinning would mitigate against the retention objective. The team did not see evidence of landscape prescriptions which addressed post-cutting phases of timber management. It is the combined responsibility of landscape architects and silviculturists to relate landscape design to silvicultural prescriptions, developing details beyond generalized VMS objectives.

Thinning of young stands on the Shoshone was not emphasized, but judging by dense regeneration seen in the Cartridge Creek area of Wiggins Fork, thinning will necessarily be a part of silvicultural management. Consideration should be given to variations of thinning techniques.

1970

1982

Figure 30. Twelve years is not long enough to restore the visual value of this rock outcropping degraded by earlier timber harvesting (Tongue River, Bighorn).

Landscape architects, through plans and field advice, need to explain how harvesting techniques can respond to local landscape attributes--creeks, boulders and outcroppings, ponds, topographic changes, wildlife hiding cover, trails. Blights on the landscape due to insensitive cutting such as the rock outcropping shown in Figure 30 can be avoided.

The need for long-range landscape planning should be emphasized. Unnatural geometric patterns such as strip cuttings of the 1950s continue to affect the look of the forest landscape. The distinctive straight lines of the strips persist even with adequate regeneration. The Fish Creek strip cuts (Bridger-Teton), virtually without regeneration, appeared no different in 1982 than in 1970 (Figure 31). Since there is a normal delay in removing leave strips while adjacent cut strips are regenerated,

1970

1982

Figure 31. Between 1970 and 1982, sparse regeneration was recorded on these high-elevation clearcuts. The visual impact of geometric strip cutting will persist for many years in contrast to natural landscape patterns (Fish Creek, Bridger-Teton).

Figure 32. These clearcut strips are now regenerated. The leave strips are no longer needed to provide seed but should be left uncut until the new stand is tall and dense enough to provide cover for big game. The unnatural clearcut shapes will persist for the life of the stand (Hoback, Bridger-Teton).

stair-step differences in stand structure and brighter, finer color texture of young growth will continue the image of the strips. Examples of strip cuttings on the Bridger-Teton (Hoback District) were not seen on the ground but were conspicuous from the air (Figure 32).

At Teepee Creek (Bighorn), a timber-cutting machine which shears off trees along a narrow path, had created a set of uniform strips perpendicular to the contour (Figure 33). These strips, conspicuous and artificial, were without satisfactory relationship to the landscape. Although smaller in scale, potential visual impacts could be similar to the arbitrary patterns seen in the Fish Creek strip cuts. While the Teepee Creek cuts may be in the nature of a trial with the equipment, they suggest a kind of visual impact that is unacceptable when retention of native characteristics is the landscape management goal. On the Dough Sale at Pole Creek (Bighorn), another harvesting machine produced irregular paths with relatively good visual effect in shelterwood cuttings.

Figure 33. A field test of a machine that harvests tree-length logs created this series of gashes in an otherwise dense lodgepole pine stand. Although only a trial, the site illustrates the visual severity of such shapes in contrast to natural landscape features (Teepee Creek, Bighorn).

Curtis Canyon strip cuttings have been modified over the years. Figure 34 illustrates changes as seen from the Grand Teton National Park observation point on Highway 26. In 1982, the issue of cutting out remaining leave strips was raised. Such harvesting would then visually demonstrate cuttings of 20 years ago, 10 years ago, and

a

b

c

Figure 34. Strip cuttings in a high visibility zone along U.S. Highway 26 in Jackson Hole are shown in 1964(a), as modified in 1969 (b), and as they appear in 1982(c). The modified cuttings could scarcely be distinguished from natural features of the terrain (Curtis Canyon, Bridger-Teton).

the present. Design of recuts should be based on graphic predictions of what future visual effects will be. If visual projection of the next round of cutting is not considered, then the advantage of the Curtis Canyon pioneering effort would be lost. The Curtis Canyon visual control method is a good predictive model for site rehabilitation, including old strip cuts. Future cuttings are used to integrate, eventually, a whole set of cuttings with surroundings. Graphic devices such as those prepared for the Curtis Canyon cuttings are suggested for routine use. They represent a simple monitoring technique. Visual impacts of old strip cuts, as well as others, can be diminished by designing new perimeter cutting patterns to fit the local landscape.

Visual quality need not remain a soft target for resource managers. The Forests have demonstrated a willingness to work landscape design into planning and management decisions. With landscape architects and the VMS still relatively new on the Forests, the time is in the future when the intent of landscape design will be consistently demonstrated on the ground. An improved Visual Management System and the proper use of landscape architects with other specialists can mean the difference between excellence and mediocrity in forest management.

Recommendations

The Forests should identify wildlife, recreation, and scenic values with national significance and recognize them in management decisions.

Landscape architects should, to the best of their ability, use professional judgment when applying the Visual Management System.

The Forests should involve landscape architects in services beyond general planning, EAs, and crisis situations to include landscape design, on-the-ground advice, and monitoring.

Visual monitoring should be essential on a full array of resource management activities.

Rocky Mountain landscapes native to the three Forests should serve as models for maintaining visual diversity.

Hydrology

In 1970, Wyoming residents described their fears about potential effects of clearcutting and roads on watersheds and fisheries. Some felt that clearcutting would increase spring peaks of snowmelt runoff and result in streambank erosion. Others felt that too many roads were being built, that faulty road planning and construction were accelerating soil erosion, increasing sedimentation of stream channels, and damaging fisheries. These concerns were understandable in the absence of detailed hydrologic information for the study Forests. In 1982, the most urgent water concern was maintaining normal function of watersheds while continuing forest resource use.

Water Quality

The 1971 Wyoming Report contained inferences on how timber harvesting might be affecting runoff, erosion, and streamflow behavior based on research in similar forests elsewhere (Hibbert 1967, Packer 1967). New research in other areas and on the Bridger-Teton (Hibbert 1979, Packer and Williams 1980, De Byle 1980, and Benson 1982) confirms the earlier work and provides conclusions about timber harvesting and water quality directly applicable to the study Forests.

Sediment production from undisturbed forests depends on the inherent stability of the soil and the magnitude of storm runoff. Volume of sediment ranges from a few parts per million in suspension during normal streamflow to several hundred parts per million during periods of high discharge. Increases in streamflow resulting from timber harvesting may cause streambank erosion and increased sediment production.

Skidding logs from the forest, especially with equipment that deeply disturbs the soil mantle, can also increase sediment production. This depends upon the location of skidways with respect to water courses, the adequacy of drainage facilities, and the magnitude of storm flows. Logging can produce sediment ranging from several hundred to tens-of-thousand parts per million. In forests with stony soil, rates of erosion caused by logging usually decline to pre-logging levels within a few years because a protective stony pavement develops on skid trails and roads. On fine-textured soils, erosion rates may continue at accelerated levels until skidways become revegetated.

Research on the Bridger-Teton in the 1970s showed that recovery of protective watershed conditions following logging residue disposal in lodgepole pine forests does not occur rapidly given the high altitude and short growing seasons. Recovery from impaired conditions is slower on sites where the vegetation and soil mantle have been drastically disturbed by mechanized equipment. The poorest surface runoff and erosion control is encountered where residue is dozer-piled and burned. The most effective and economical residue treatment in terms of protection to water quality is broadcast burning. However, weather conditions often limit successful application of the broadcast burning practice and piling and burning is frequently used as a logging residue treatment method. Mineral nutrient losses from logged and burned sites are minimal and of short duration.

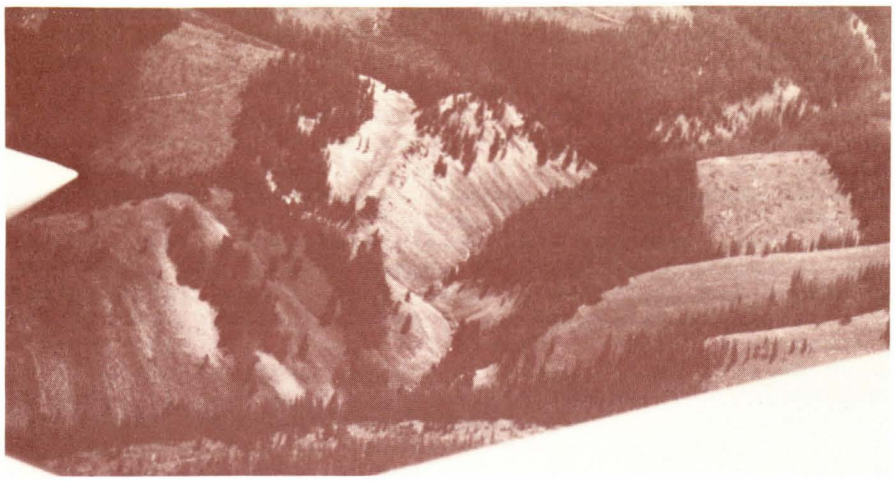


Figure 35. Natural landslip topography contributes to stream degradation and influences forest management decisions (Wyoming Range, Bridger-Teton).

Most damage to water quality from timber-harvesting activities can be avoided if forest managers utilize available water-control information.

The Bridger-Teton is characterized by rougher, steeper, and more landslip prone topography than the other two Forests (Figure 35). Studies in 1972, showed that about 18 percent of the Teton National Forest was surfaced by slides of over 20 acres. Another 40 percent had smaller slides prevalent (Bailey 1972). Greater potential exists then for landscape disturbance, overland flow, soil erosion, and sedimentation of streams under impacts of land use. Natural landslips frequently occur adjacent to or into stream channels, and resultant stream sedimentation is of greater magnitude than from any other source. The Hoback River (Bridger-Teton) is a prime example of sediment damage to water quality attributable mainly to landslip topography (Figure 36). The river picks up sediment loads--largely from erosion of natural landslips but also from roads--in its steeper upper reaches and deposits this sediment at the gentler gradients of its lower reaches. This action results in braided stream channels of the lower Hoback and also of such pristine streams as Wiggins Fork (Figure 37).

The Bighorn has the gentlest topography of the three Forests and timber can be harvested in most places with a minimum risk of landscape disturbance or damage to soil and water quality. The 1982 study team observed that, on timber harvest areas visited, adequate vegetation and logging debris were controlling overload flow of water.

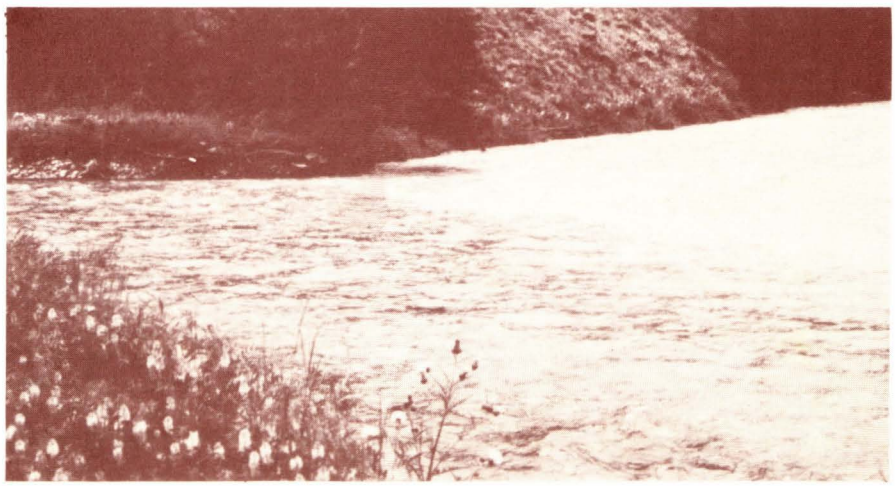


Figure 36. Granite Creek, running clear, joins the Hoback River which carries sediment after a heavy rainstorm (Bridger-Teton).

Figure 37. A braided stream channel develops from deposition of sediment over many years. Sediment loads are deposited where stream gradients decrease. This phenomenon is common and is usually not related to forest management activities (Wiggins Fork, Shoshone).

Depression storage was trapping eroded soil before it could move off-site. Timber harvest sites appeared to be well-managed. They were neither eroding nor damaging the quality of water in streams. The Forests should continue to maintain sufficient protective vegetation and logging debris on the ground at harvest sites to prevent accelerated overland flow.

On each of the Forests, the team visited sites where harvesting predated the 1970 review. Inadequately drained skid trails were observed in a number of places (Figure 38). Most of these were eroded, mainly with small rills, but a few with deeper gullies. Such eroded soil, even though trapped in depression storage and not supplying sediment to streams, still implies deterioration of site quality due to accelerated downslope movement of soil. The Forests should see that skid trails are drained at frequent intervals to prevent concentrations of water from eroding rills and gullies.

Following logging, forage increased substantially on timber harvest areas, especially on clearcuts. These areas are now being used extensively on each of the Forests as transitory livestock range. Evidence of damage to young trees and disturbance from livestock trampling was observed by the team (Figure 39). Disturbance in some places has resulted in breakdown and erosion of streambanks where livestock congregate to cross streams or to drink. Grazing and trampling disturbances as a source of water quality damage should not be confused with nor attributed to timber harvesting activities. Where

Figure 38. Skid trails, at right angles to the contours of a site, even on gentle slopes, require drainage devices such as water bars to divert runoff into adjacent duff and litter (Owens Creek, Bighorn).

Figure 39. Open-range livestock have damaged young trees (above) on a lodgepole pine plantation and have caused streamside erosion by trailing to nearby water (Preachers Park, Bridger-Teton).

increased forage on timber harvest areas has resulted in intensive grazing and trampling disturbance, the Forests should institute livestock management measures to control erosion of riparian sites and damage to regeneration.

In the study team's opinion, timber management, using improved harvesting technology, can be undertaken on most of the Forests' watersheds without threat to water quality. In 1971, the team recommended that monitoring results of management activities should be an integral part of the land management job. In 1982, there is still virtually no instrumentation for regular water quality sampling, either in watersheds where timber management actions are planned or in watersheds where such actions have already occurred. In the team's opinion, the Forests cannot afford this omission of hard technical information. This deficiency may seriously jeopardize the credibility of decisionmaking for future management actions with potential for affecting the quality of streamflow.

Water Yield

Manipulating vegetation to influence amount and time of delivery of water as streamflow from the study Forests is currently a topic of discussion in Wyoming. The effects of manipulation on water yield are well known. Beginning in 1911 at Wagon Wheel Gap, Colorado (Bates and Henry 1928) and extending to the present, research has been conducted to determine how much, when, and under what conditions of climate, soil, and topography, different forest treatments affect water yields (Hibbert 1967 and 1979). Evidence from 17 locations in the United States, as well as from sites world-wide, supports the observation that reduction of forest vegetation increases and reforestation decreases water yield. Permanent increases in streamflow cannot occur in areas of less than about 16 inches of annual precipitation. A practical upper limit of water-yield increase appears to be about 1/6 acre-inch per year from each percent reduction in forest cover, but most treatments produce less than this amount.

Most of the water for streamflow from western coniferous forests comes from accumulation and melting of snow. The maximum content of water in the snowpack on the ground increases in direct proportion to the amount by which overhead openings in the forest canopy are created or enlarged (Packer 1962). Silvicultural treatments, ranging from thinning through various intensities of partial cutting to clearcutting, produce correspondingly greater accumulations of snowpack water. Measurements of

snow courses in cut forest stands of varying conditions confirm this conclusion.

Timber harvesting redistributes snow within a watershed and alters melting rates but has little influence on the total amount of snow received by a watershed. Trees absorb water from the soil and, through transpiration, release it to the atmosphere. Transpirational loss of water to the atmosphere is reduced when trees are harvested and increased as new trees become established and develop into a forest. The magnitude of increase or decrease in streamflow depends almost entirely upon the number of trees harvested or reforested on an area at any given time.

In addition to quantity of water, timber harvesting and reforestation can change rate and time of streamflow. Forest cover affects rate and time of snowmelt, permeability and storage of the soil mantle, and capabilities of watersheds to synchronize streamflow. Forest hydrologists are knowledgeable about timber harvest and reforestation effects on amount of streamflow and rate of snowmelt on different aspects at different elevations (Packer 1971). They also have considerable information about the effects of such activities on the amount of streamflow (Hibbert 1967). Not as well understood are synchronization characteristics of different watersheds and their effects on the time of streamflow. This information will not be available on the study Forests until a program of streamflow measurements at carefully selected gaging sites is funded. Water quality monitoring of streamflow for water amount and time of flow, recommended in the 1971 report, has not been implemented sufficiently to be of much practical use for evaluation of timber management effects on water yields.

The current need for additional water in the Green-Colorado River Basin is unquestionable. Public concern about proposals to increase water yields by timber harvesting on the Green River Watershed (Bridger-Teton) led to a feasibility evaluation by Galbraith in 1982. A management alternative to increase water yield proposed converting over 5,100 acres per year from forest to early stages of plant succession by cuttings in the forest.

The proposed conversion program has limitations and may well be outside the legal authority conferred by federal law on the Forest Service. Some wildlife species, protected by law, would be reduced below viable population levels and certain roadless recreation opportunities would be lost. Implementation would entail difficult compromises between conflicting multiple-use values.

Research has shown that water-yield increases from harvesting coniferous timber would likely persist for at least 20 years. During this recovery period, higher streamflow could be expected to erode stream banks and increase the sediment load in streams. To mitigate such effects, an upper limit of 30 percent has been established by all western Wyoming Forests for the amount of area that can be harvested in any major watershed until water-increase recovery takes place. This means that the timber can be removed from no more than 30 percent of a watershed during any 20-year period. The study team suspects that, given the young, open-grown trees on 10- to 20-year old clearcut areas on these three Forests, the persistence period might well be as much as 30 or 40 years.

On the Bighorn, the study team observed apparent effects of increased streamflow as a result of timber harvesting in Pole Creek, a watershed of about 6,300 acres in size. Approximately 40 percent of the forested area of this watershed was clearcut over a period of 10 or 15 years beginning in the early 1960s. While the topography

is relatively gentle, and neither clearcuts nor roads infringe upon streams, evidence of the effects of timber cutting appears in the form of higher streamflow peaks, increased streambank undercutting and erosion, increased scouring of steeper sections of stream channels, and deposition of sediment in lower gradient stretches. Evidence suggests that this watershed, with 40 percent of its forest area cut, may have been overcut beyond a safe level for protection of streambank and stream channel stability. This situation is recognized by forest personnel and lends credence to an estimated upper limit of no more than 30 percent of a watershed area from which timber can safely be removed. This limit has been established as a management constraint which, if adhered to, most likely precludes any wholesale program of timber harvesting on the Bridger-Teton to increase water yields in the Green River drainage. The study team supports this constraint until research or monitoring can show a different permissible or required limit. The recommendation made in 1971 that ''research should determine the kinds and sizes of areas and proportions of watersheds that can be safely clearcut at one time without creating damaging changes in streamflow quantity, quality, or timing'' has not been implemented on the western Wyoming Forests--and needs to be.

Recommendations

Protective vegetation and logging debris should be maintained on timber harvesting sites to prevent accelerated overland water flow.

Skid trails should be drained at frequent intervals to prevent concentrations of water that would erode rills and gullies.

Where increased forage on timber harvest areas has resulted in intensive grazing and trampling disturbance, the Forests should institute livestock management measures to minimize damage to riparian sites and regeneration.

The Forests should conduct periodic and frequent evaluation of the effects of timber management activities on water quality as an integral part of the land management job.

The Forests should monitor streamflow for water amount and time of flow to evaluate timber management effects on water yields.

Research should determine the kinds and sizes of areas and proportions of watersheds that can be safely clearcut at one time without creating damaging changes in streamflow quantity, quality, or timing.

Road Design and Maintenance

In Wyoming roads or their exclusion present problems which affect the use of all forest resources. For logging, roads are essential. Small stems and low volumes of timber make innovative transportation practices, such as helicopter or balloon logging, economically unfeasible. Forest roads--standards, density, maintenance, and management--continue to cause concern among different segments of the Wyoming public.

Some people feel that roads have been built to standards higher than needed causing excessive construction costs, unnecessary disturbance of soil, damage to water quality, and deterioration of forest esthetics (Figure 40). Some complain that roads are inadequately maintained, leading to watershed damage and causing dangerous travel conditions on parts of the Forests. Others are concerned with road density--miles of

1970

1982

Figure 40. Visual degradation of scenic areas may persist for many years if logging residue along access roads is inadequately cleared. In 1970, this road near a main trailhead to a primitive area was criticized for unsightly debris. Improvement has not been significant. Scenic areas such as this deserve special attention in timber harvesting and road building activities (Brooks Lake, Shoshone).

roads built in specific areas or drainages. Many people are critical because they are still unable to get firm answers from forest personnel about which presently unroaded areas will be roaded and to what density. Forest personnel reported that the public has been involved in road density discussions. Public concerns about road density in specific areas are considered in forest plans now being developed. The projected forest road network for the 10-year planning period will be available to the public when plans are approved. The study team suggests that transportion plans indicate the purpose of every road and the construction needed to meet management objectives. Plans should be clear, logical, and in a form easily understandable by the public. Drainages exempt from road construction or to be managed with temporary roads only should be specified.

1970

1982

Figure 41. In 1970, residue cleanup on this critical roadside zone was considered inadequate by the study team. Twelve years later, settling of debris and growth of vegetation has begun to restore the natural meadow appearance. If debris had been burned or scattered, restoration would have occurred years earlier (Flagstaff Road, Bridger-Teton).

Road Construction

Public concerns in 1982 were similar to those addressed by the study team 12 years ago. Except for the location of future roads, they related almost invariably to roads built prior to 1970. A number of these older roads were overly wide, overly steep, located too close to stream courses, and without adequate drainage facilities. They did, in fact, contribute to deteriorated water quality. Some still do. The study team saw culverts which were partially or totally plugged, providing unsatisfactory drainage. On some steeper grades, the team observed ineffective water bars and dips. Water had flowed a quarter mile or more down some road sections before being diverted. These deficiencies have remained uncorrected since 1970. In 1971, the team recommended that ''roads still open should be carefully evaluated; those classified as temporary should be closed and all others reconstructed as required for maintenance as part of the permanent road system.'' In general, roads that have been closed since then are drained satisfactorily. Roads remaining open and subject to continuing traffic need to be reconstructed with better and permanent-type drainage facilities. Some older roads were well designed but disturbed the landscape due to inadequate right-of-way clean up for critical zones (Figure 41).

Forest personnel have made noteworthy progress since 1970 in matching road standards to resource management requirements. A high degree of quality control in design and construction has resulted in new roads being narrower, better fitted to the topography, and much less disturbing to the landscape. They are characterized by built-in drainage facilities that reduce maintenance needs and costs. These measures have protected and often enhanced other resource values. The access roads into the Teepee Creek Sale (Bighorn), the Long Creek Sale (Shoshone) and the Spring Creek and Red Creek Sales (Bridger-Teton), are prime examples of good road design and construction (Figures 42 and 43).

A few roads built since 1971 have been over designed, located on highly erodible sites, or constructed without adequate drainage facilities. One of these, the access road in the West Fork of the Big Goose Creek (Bighorn), should be reworked to correct omissions of reverse-grade rolling dips, downspouts, and energy dissipators in sections built through highly erodible granitic soils. Guides for designing and constructing drainage on forest roads to keep sediment out of streams were developed by research before this road was built (Packer 1967). An inexpensive construction technique, the reverse-grade rolling dip for water drainage, is suitable for improving

Figure 42. This new road, designed to a standard adequate for timber harvesting, also serves recreation and other uses. The road was fitted to the land for minimal disturbance of soil without sacrificing adequate drainage (Teepee Creek, Bighorn).

Figure 43. Gentle terrain provided the opportunity to design and locate this road for multiple use. Alignment between reverse curves and tidiness of the roadside zone increases utility (Long Creek, Shoshone).

drainage on both old and new roads. This technique has considerable value for lowering costs of construction and reconstruction and reducing long-term maintenance needs.

Roads can offer opportunities for pleasant drives through the forest and provide access to recreation use areas (Figure 44). New roads built since 1970, limited in numbers as they are, can generally be commended for modest standards and desirable relationships to the landscape. They demonstrate attributes of scenic roads. Worthy of note are appropriate standards and design fit, narrowness, high-radius curves, low cuts and fills, and commendable construction. Roads such as these are improvements over many roads built before 1970. Forest personnel should insure that road location, design, and construction continue to be coordinated with the landscape. This will require thorough exploration of visual alternatives, special attention to visual corridors, and use of flexible road design standards that encourage the smallest scale road appropriate for proposed use.

Figure 44. A scenic aspen stand traversed by a well-designed forest road enhances recreational use (Antelope Mountain, Bridger-Teton).

Road Closures

Road closures were viewed by some people as an unreasonable denial of vehicular access for hunting, fishing, camping, and gathering forest products such as berries, firewood, posts, and poles. Others supported road closures especially to protect wildlife.

All three Forests have developed road-closure programs, and many timber sales now include road-closure provisions. The team's concern is that plans and performance may not coincide. Though each Forest estimated 80 to 90 percent compliance with current road closure programs, past performance does cast some doubt on Forest Service commitment. Consistency is needed in road closure policy and performance.

Several methods are available for achieving road closures after logging (Figure 45). The Bridger-Teton has installed a number of steel-pipe gates with posts anchored in concrete. The study team was also shown a few closures in which large rocks and logs had been moved into a permanent barrier. In one sale area on the Shoshone, roads had been completely restored to original contour and seeded to grass as part of the timber sale contract. This Forest also has some steel-pipe gates and quite a few apparently successful closures in which the only barrier is a wooden fence post with a small ''vehicles prohibited'' sign. On the Buffalo District of the Bighorn, a substantial number of roads have been closed with attractive wooden gates constructed under the Older American Program.

The team was told that each of these techniques has associated problems. Steel-pipe gates are expensive, and despite their sturdy construction, some have been destroyed. Barriers consisting of a single wooden post have been pulled up or broken.

On the other hand, many wooden posts have survived undisturbed while the road filled in with native or seeded vegetation. Only one of the wooden gates on the Buffalo District has been broken. Most simple permanent barriers have worked well.

A new incentive has been added to road closure programs in Wyoming. Restrictive budgets for road maintenance and construction have led Regional Foresters to issue similar directives: no new roads can be constructed unless equivalent old roads are closed. The study team believes that these directives may produce some unexpected road management problems. Public support will be crucial to their success. The alternative is law enforcement, undesirable except as a last resort.

Success or failure of road-closure programs appears to be a function of attitude rather than technique. The public requires logical explanations for road closures. Prevention of erosion will not be accepted as a good reason for closure when a road has been open for 25 consecutive years without perceptible resource damage.

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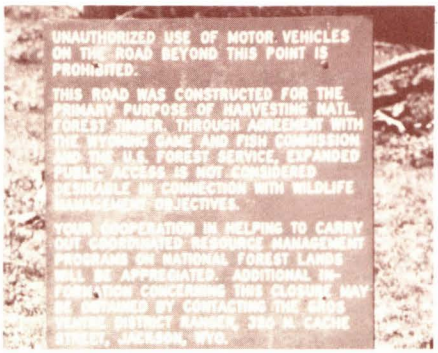

UNAUTHORIZED USE OF MOTOR VEHICLES ON THE ROAD BEYOND THIS POINT IS PROHIBITED.
THIS ROAD WAS CONSTRUCTED FOR THE PRIMARY PURPOSE OF HARVESTING MATURE FOREST TIMBER. THROUGH AGREEMENT WITH THE WYOMING GAME AND FISH COMMISSION AND THE U.S. FOREST SERVICE, EXPANDED PUBLIC ACCESS IS NOT CONSIDERED DESIRABLE IN CONNECTION WITH WILDLIFE MANAGEMENT OBJECTIVES.
YOUR COOPERATION IN HELPING TO CARRY OUT COORDINATED RESOURCE MANAGEMENT PROGRAMS ON NATIONAL FOREST LANDS WILL BE APPRECIATED. ADDITIONAL INFORMATION CONCERNING THIS CLOSURE MAY BE OBTAINED BY CONTACTING THE FOREST
e

d

Figure 45. Logging roads can be closed by several methods: (a) Some roads are obliterated when access is no longer needed (Shoshone). (b) Seeding to grass and use of a small sign with a motor vehicles prohibited symbol often are enough (Shoshone). (c) Boulder and log barriers do the job and are cost-efficient (Bridger-Teton). (d) Iron gates, effective but costly, can be reopened for administrative or emergency use (Shoshone). (e) Signs explaining reasons for road closures promote public cooperation (Bridger-Teton).

Protection of wildlife habitat will not be a convincing reason if concurrent logging appears to have involved little consideration for wildlife. Forest personnel should involve the public in planning road closures. The public will be more likely to respect road closures if benefits of the program are made evident.

Recommendations

The Forests should indicate in transportation plans the purpose of every road and the level of road construction needed to attain stated management objectives. Plans should be logical, presented in a form understandable by the public, specifying drainages that will be exempt from road construction or managed with temporary roads only.

The team repeats a 1971 recommendation that ''roads still open should be carefully evaluated, those classified as temporary should be closed, and all others reconstructed as required for maintenance as part of the permanent road system.''

The Forests should continue to improve the quality of design, location, and construction of new roads to prevent damage to soil and water.

The Forests should insure that road location, design, and construction is coordinated with the landscape. This will require thorough exploration of visual alternatives, special attention to visual corridors, and the use of flexible road design standards that encourage the smallest scale road for the proposed use.

The Forests should strive for consistency in road-closure policy and commitment to road-closure performance.

The Forests should involve the public in planning road closures and insure that reasons for road closures are understandable and in the interests of forest resources.

Problems: Emerging and Remaining

Forest managers in Wyoming are faced with difficult choices. Decisions are based on interrelationships, political as well as ecological.

Contacts with forest personnel and with local residents impressed the study team with the array of considerations involved in planning. Forest managers in Wyoming are being asked to maintain a delicate resource balance between sometimes competing concerns. In this regard, some old problem areas and some weighty new ones merit attention.

Staffing and Funding

Multiple-use management requires integrating resource practices to meet objectives. Circumstances vary from location to location, but on each of the study Forests, personnel provide the following services: maintaining water quality, water yield, and soil productivity; controlling pests and diseases; maintaining visual quality; establishing botanic, aquatic, and geologic natural areas; producing timber and wood fiber; maintaining habitat for endangered species; assessing mineral explorations; providing transportation facilities; authorizing transportation, powerline, and other transmission corridors; maintaining fish and wildlife habitat, managing for outdoor recreation and wilderness, retaining wilderness options, and administering livestock grazing. The quality of multiple-use management is dependent on available skills, information, time, and money. In 1970, the study team noted inadequacies and imbalance in staffing and funding on the Forests. Many on-the-ground mistakes were traceable to these deficiencies.

The team then recommended that timber sales include silvicultural prescriptions written by qualified silviculturists and that better use be made of knowledge from other specialists. The response has been gratifying. Staffing has improved markedly as Table 5 reveals. The last six disciplines in Table 5 were just being recognized on the Forests in 1970 when only five specialists were employed. Currently, 33 specialists are listed for the three Forests. The services of resource economists are available on a zone basis, from the regional office, or from private consultants. Qualified specialists provide the expertise essential for quality multiple-use management.

On-the-job training has been upgraded to broaden skills. A program to certify silviculturists from among selected foresters has been initiated in each Region within the last 10 years. Silvicultural prescriptions on the Forests are now written or approved by these specialists.

A training program in archeology has also been established. Personnel on each Forest are trained as paraprofessionals to make field examinations, recommend proper protection measures, and judge when services of a professional archeologist should be used.

Table 5. Numbers of Technical Specialists on the Bighorn, Shoshone, and Bridger-Teton National Forests

	Bighorn			Shoshone			Bridger-Teton		
Specialist	1970	1977	1982	1970	1976	1982	1970*	1976	1982
Forester	15	18	24	15	10	19	16	7	7
Engineer	4	6	5	4	2	3	10	6	9
Range conservationist	6	6	9	2	1	5	9	9	8
Certified silviculturist	0	0	1	0	0	1	0	2	5
Landscape architect	0	0	2	0	1	1	1	1	1
Soil scientist	0	0	1	0	1	1	0	2	2
Hydrologist	1	0	1	0	1	1	1**	1	1
Wildlife biologist	0	1	2	0	1	3	2	2***	9***
Ecologist	0	0	0	0	0	0	0	0	1

Source: USDA Forest Service, 1982.
* 1970 figures represent a compilation of specialists on the Bridger National Forest and the Teton National Forest which were merged in 1973.
** Combines soils and hydrology
*** Includes fisheries biologists

Needed changes in staffing patterns are recognized by the Forest Service. The increase in specialists has been accomplished by increased appropriated funding, by reducing overhead costs through consolidating Forests and ranger districts, and by in-service training of employees. Forest managers see the need for additional personnel to help accomplish a balanced program. Funding is felt to be inadequate to manage the Forests for outdoor recreation, wildlife, wilderness, roads, and trails.

Inadequate funding may be the source of some current public issues. In 1982, the study team shared with the public a concern that commodity uses were being considered over amenities. Forest personnel indicated that they could understand how this impression might be given. In recent years, the national trend to reduce federal spending and employment has affected the national forests. Programs that produce revenue for the U.S. Treasury or those with potential to ease the energy situation have been better funded than wildlife habitat improvement, outdoor recreation, or wilderness management. On the Bighorn, landscape architects and some other specialists are surplus positions--no longer covered by the budget. On the Bridger-Teton, the forest ecologist position is being abolished.

The study Forests are striving to accomplish balanced multiple-use management. Many of the improvements observed in 1982 were direct results of the availability of specialized expertise. Add-on assignments cannot take the place of specialists. If they are let go due to inadequate funding just as their influence is being felt, the quality of future management can only suffer.

Recommendation

The Forests should make a concerted effort to retain specialist positions essential to quality multiple-use management or to adjust scheduled accomplishments to levels consistent with the qualified staff available.

Recreation

The northwest corner of Wyoming receives world-wide attention because of Yellowstone and Grand Teton National Parks. Five wilderness areas on the study Forests attract additional tourism and backcountry recreationists. In 1970, the study team noted that the Forest Service had recognized the significance of recreation on the national forests in Wyoming, but recognition alone had not provided proper coordination in management planning. Today, the problem has become critical. Public contacts revealed concern about the relationship of timber management and recreation. In addition to big-game hunting, dispersed recreation--backcountry hiking and camping--was mentioned. On several occasions at public meetings, participants reported direct conflict between dude ranching operations and proposed timber sales.

Outfitting is a big business in Wyoming. A study in Teton County estimated that big game outfitters on that area of the Bridger-Teton generated $2.4 million in direct sales to hunters and $4.2 million in total sales during 1980 (Taylor et al. 1982). Dude ranches provide guides, horses, and camping supplies for trail rides into unroaded areas on national forest lands. Critics contend that these operations cannot continue on logging roads through clearcuts. Each of the Forests has at least one situation where planned roads and logging will adversely affect existing dude ranches.

How should the Forest Service decide? In favor of local recreation businesses or local timber companies? Foregoing entry into unroaded areas benefits outfitters, while building logging roads helps timber companies. Sparing unroaded areas can be accomplished at no expense to the government, but timber sales may return cash to the U.S. Treasury and create local jobs. Is the question economic or social? Perhaps no clear and simple answer is possible. The study team saw evidence that recreation alternatives were considered, but decisions were usually in favor of timber harvest. In cases of conflict, decline of recreation opportunity appeared to be viewed by forest personnel as the regrettable result of inevitable decisions.

The study team suggests only that a different approach might be possible. With careful planning, rerouting of trails, and modification of either total timber harvest or cutting method, areas of incompatibility could be avoided. The point is not so much whether compromise is possible, but that it should be considered.

The study team views the Bridger-Teton recreation budget as a major unresolved problem. It has remained a problem for more than a decade. This Forest, because of its location, has a campground and overnight camping load comparable to adjacent Grand Teton National Park. Yet, the recreation budget has not been funded for new facilities in over 15 years, and annual budgets for

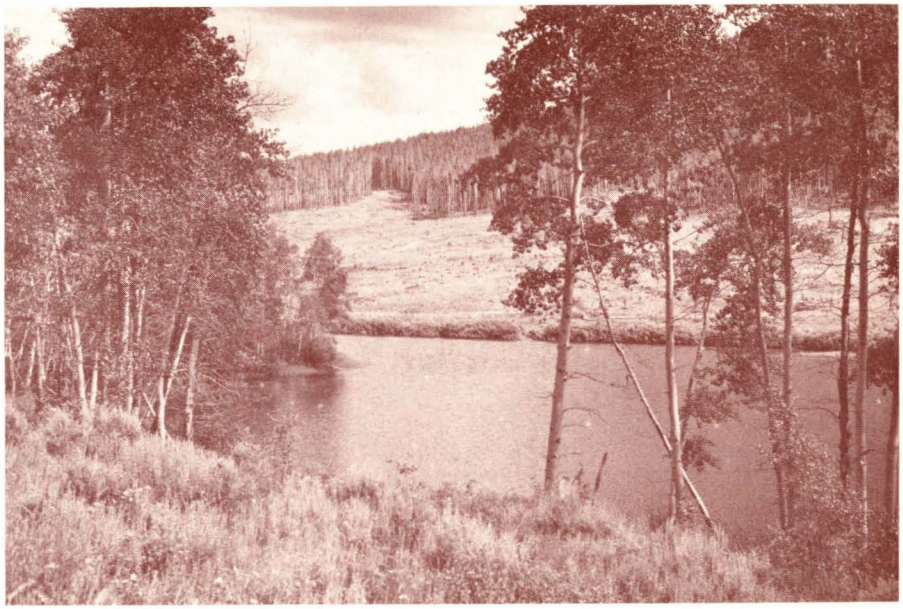
maintenance have declined due to inflation. On some ranger districts, available funds are inadequate for routine maintenance and repair of damage due to vandalism. The much-needed solution will likely come from an administrative level higher than the Forest or Region.

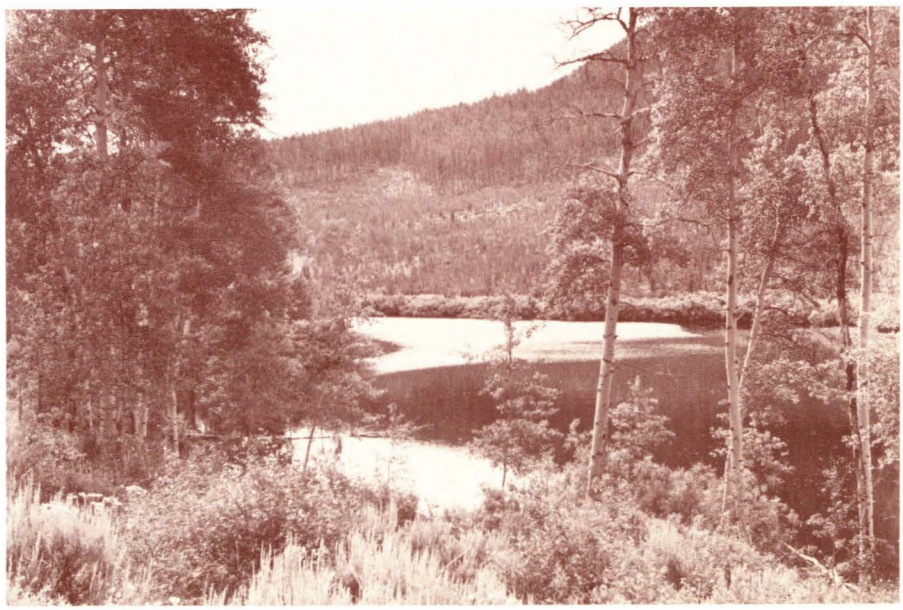
Recreation on the study Forests is not restricted to wilderness experiences or to big-game hunting. Activities range from familiar family campouts to such exotic sports as white-water rafting and helicopter skiing. Quality recreational experiences can be enhanced by management activities. Timber harvesting need not detract from the scenic quality of the Forests as Figure 46 shows.

Recommendation

The Regional Foresters should recognize the national significance and the unusually high impact of recreation on the Bridger-Teton and Shoshone and, insofar as possible, allocate funds to accommodate this use.

1970





1982

Figure 46. This timber harvest was designed to protect the scenic quality of the site. The exposed surface of the cutover area in the background is almost covered by young trees 12 years later (Spread Creek, Bridger-Teton).

Oil and Gas Exploration

The Shoshone and the Bridger-Teton are experiencing Wyoming's energy boom. The Bridger-Teton is traversed by the ''Overthrust Belt,'' a complex geologic structure, 40 to 60 miles in width, which extends from Utah to Canada. The U.S. Geological Survey estimates that some 15 billion barrels of oil and 65 trillion cubic feet of natural gas may be trapped in sedimentary rock pockets of the Belt.

As a result of rising crude oil prices in the last decade, oil and gas exploration has increased manyfold in Wyoming. Although these activities are booming, they are not new. On the Bridger-Teton, the first drilling began in 1928. Drilling and seismic activity, preparatory to drilling, has shown a burst of activity in recent years.

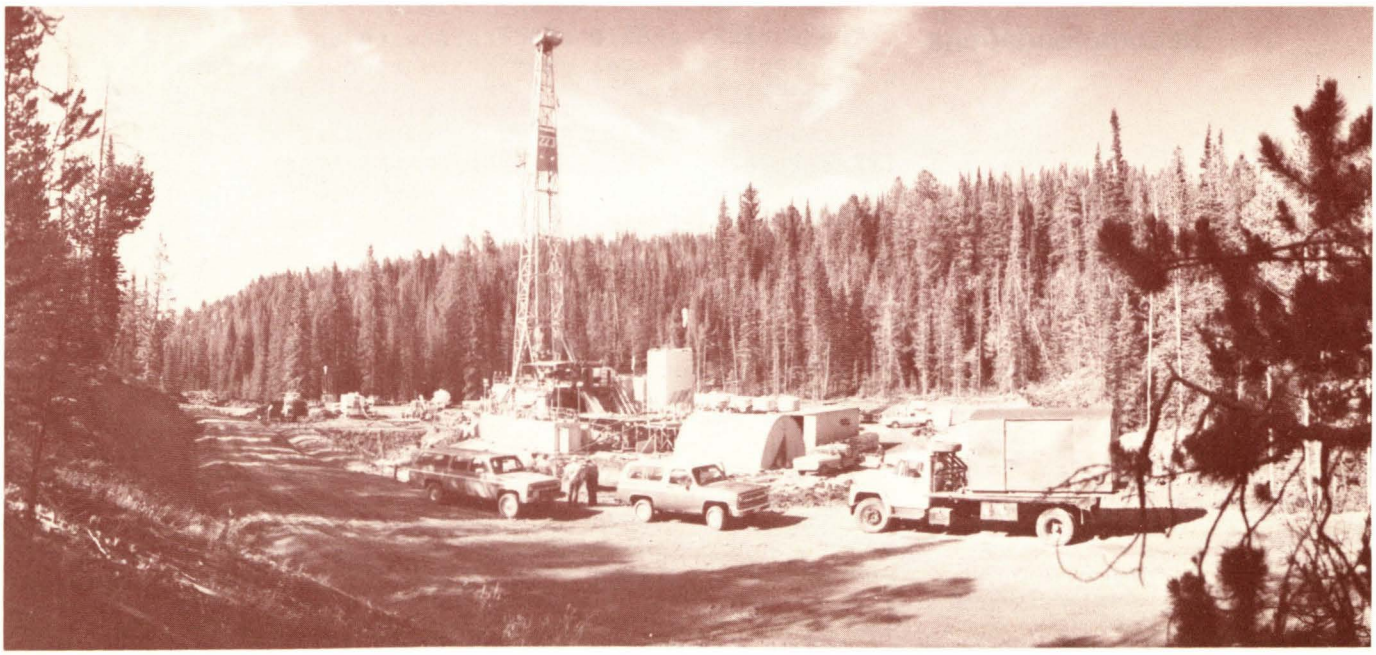
Impact on forest resources is unavoidable. Well drilling involves heavy construction and equipment, which in turn requires roads built to a higher standard than for other resource management activities. Many of the proposed well sites are located in unroaded areas. Public concern about roads and wildlife can be expected to increase.

The Department of the Interior has the authority and responsibility for issuing mineral drilling permits on national forest land. The Forest Service is responsible for management of surface resources. Forest personnel evaluate proposed drilling sites and offer recommendations prior to permit. An EA is prepared and activity is monitored by forest personnel. The Forests should cooperate with the Interior Department in keeping local and State agencies informed on oil and gas activities.

Forest personnel reported good working relationships with drilling companies who are following Forest guidelines and standards for roadbuilding, well-site development, and site rehabilitation. On the Bridger-Teton, oil companies have contributed special funds to augment Forest Service personnel in permit and site administration.

The study team saw examples of well-engineered roads, though to a much higher standard than needed for ordinary forest roads. The Long Creek Road (Shoshone) now provides access to an oil drill site (Figure 47). Road construction has been held to minimum standards, alignment

Figure 47. Oil and gas activities are increasing on the Bridger-Teton and the Shoshone. Drilling sites and access roads will affect wildlife habitat, landscape design, and recreation (Long Creek, Shoshone).



fits the gentle terrain well, and right-of-way clearing has been no more than necessary. Another example of present oil drilling is the Hoback exploration site at Granite Creek (Bridger-Teton) which includes a road and other accommodations. The access road for the exploration rig is of quite high standard, about the same as the access road to Granite Creek itself. The oil platform covers 4 acres of land, with cuts and fills of about 10 feet. The rig is conspicuous from Granite Creek Road since it is seen as a skyline image.

Across from Granite Creek, gas drilling took place about 20 years ago. The site, impacts obliterated by regrading and revegetation, is now virtually invisible unless its presence is known--a good demonstration that rehabilitation can be accomplished.

Current oil and gas activities relate only to preliminary investigations (seismic surveys) and to exploration (test wells) which are essentially temporary disturbances. Should exploration lead to producing wells, impacts will be greater and longer lasting.

The development phase of present exploration is expected to start as early as 1983 in the Riley Ridge area (Bridger-Teton). More well-drilling, construction of access roads, pipelines, utility lines, storage tanks, camps, and buildings are planned. A production phase of 30 to 50 years will affect more land area and resources. The abandonment phase will then begin with--at least on the national forest lands--equipment, structures, and buildings dismantled, fields cleaned up, wells plugged, hazards to people and watercourses removed, and entire fields rehabilitated.

Local residents share with forest personnel concern about the impact of gas and oil activities on other forest resources. It is a controversial public issue. Misinformation or lack of information on mineral development could only contribute to public distrust. The road network needed for oil and gas exploration is sure to raise questions. Forest personnel should keep the public fully informed on locations of exploratory roads, expected road density, plans for road management, and ways that these roads will relate to other resource uses.

Recommendations

The Forests should cooperate with the Interior Department in keeping local and State agencies informed on oil and gas activities.

Forest personnel should keep the public fully informed concerning oil and gas exploration and development proposals especially for unroaded areas.

Site Rehabilitation

Even minor change in the mountain landscape is construed by some Wyoming residents as visual degradation. Proper implementation of new forest plans should alleviate impacts of future management activities on the landscape, but poorly regenerated sites from past harvesting require active rehabilitation.

In the 1971 Wyoming Report, the study team recommended corrective action on several obviously degraded sites. In a number of areas, the recommendation was followed, but the team must state its concern regarding actions yet to be taken.

Jules Bowl (Shoshone), logged in the 1960s, remains a derelict landscape (Figure 48). It is a trailhead to a major wilderness area with a proposed wilderness addition. The site has remarkably scenic surroundings and is located near recreation facilities. Public controversy over the kind of logging carried on at Jules Bowl contributed to establishment of the 1970 Wyoming Forest Study Team. In its 1971 report, the team concurred with the public and recommended that vigorous action be taken to rehabilitate Jule's Bowl.

In 1982, the team made a return visit. The site, virtually unchanged, was a major disappointment. Scars of logging from 20 years ago are still evident. Partially piled and shattered tree trunks jutted grotesquely 10 to 15 feet in the air, muted only slightly by lodgepole plantings and natural spruce and subalpine fir regeneration. Side drainages are still plugged with debris left by logging tractors. In 1970, a U.S. Senator was quoted as saying the area resembled one bombed by a squadron of B-52s. His description remains apt. Simply admitting past mistakes is not enough. Land stewardship requires correction as well as resolve to avoid repetition.

1970

1982

Figure 48. This logging site in a high mountain basin was controversial in 1970. Natural regeneration during the 12-year interval has failed to moderate the harsh visual impact (Jules Bowl, Shoshone).

Clearcuts in the Gypsum Creek-Moose Creek area (Bridger-Teton) have a history of management plans but no follow-through (Figure 49). Harvested from 1958 to 1968, these sites encompassed 670 acres (Moose Creek) and 1,035 acres (Gypsum Creek). Clearcutting was originally prescribed to control a spruce budworm epidemic which developed after a severe blowdown. The project was designed to remove infested trees while the insect was in the larval stage. Devastating as the visual impact was, the clearcuts may well have prevented spread of the epidemic, but the public was alarmed by the appearance of the sites. In the 1971 Wyoming Report, the team recommended a regeneration checklist for each timber sale and backup treatments to compensate for stocking failure. The official response of the Regional Foresters, issued in 1971, stated:

> We concur. Current instruction will be expanded and training provided so that this recommendation can be carried out by the Forest Supervisors.

In 1982, the study team reviewed the files on Moose Creek-Gypsum Creek at Forest headquarters. An office memorandum which was dated 1973 suggested "selective regeneration--detailed site prescriptions for most critical areas as related to esthetic point of view, most suitable for timber production, and cover needed to control runoff." A 1975 memorandum identified the problem as unsightliness and lack of regeneration. Five alternatives were proposed:

1. No further planting.
2. Do what is needed to regenerate entire area.
3. Permit grazing but protect existing regeneration.
4. Selectively regenerate.
5. Clean up the area for esthetic purposes.

Figure 49. Harvested in the 1960s to help control a spruce budworm epidemic, this site remains inadequately stocked despite Forest Service assurances that rehabilitative steps would soon be taken (Moose Creek, Bridger-Teton).

1982

Selective regeneration was chosen for an action plan.

In 1981 the Forest Supervisor, responding to a letter critical of the Gypsum Creek-Moose Creek area, acknowledged that a great deal of regeneration work was needed and stated that corrective measures would be taken.

In 1982, some young growth was apparent on the sites--conspicuously heavy around seed wall edges and excessively thin in the middle. Efforts to regenerate have been inadequate, unsuccessful, or both. The access road was also in a poor state with potholes and drainage problems.

Documented intentions demand follow-through. Credibility of forest personnel is at stake.

Recommendation

The study team repeats the recommendation made in 1971: The Forests and Regions should evaluate timber harvest areas that have drawn repeated public criticism and begin major rehabilitation programs where necessary to improve the visual image and protect other resource values.

Recommendations: Then and Now

In 1982, virtually all Forest Service administrators and specialists on the three Forests were different individuals from those the team met in 1970. Filling of vacated positions and addition of new specialist positions account for personnel changes.

Current forest managers and some before them inherited the problems identified in the 1971 Wyoming Report. They have been responsible for carrying out recommendations made by the study team and acknowledged by the two Regional Foresters at that time.

Response to 1971 Recommendations

An evaluation of compliance by each Forest was included in the charge given to the 1982 Wyoming Forest Study Team. Table 6 represents a summary of recommendations made in the 1971 Wyoming Report plus a compilation of Forest responses observed in 1982. Many of these recommendations have been addressed in previous chapters. Clarifying comments on the evaluation are included in the table where pertinent. The ''report card'' format provides a brief and, it is hoped, helpful yardstick for measuring progress in forest management over the past 12 years.

Table 6. Survey of Responses by the Bighorn, Shoshone, and Bridger-Teton

C = commendable progress

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
Basic Recommendations:			
The importance of wildlife, recreation, and scenic quality as key values should be recognized in every management decision on the national forests of Wyoming. Comments: In 1982, scenic quality lagged behind wildlife and recreation.	I	I	S
Multiple use planning should be a team effort, using input from Forest Service specialists in all appropriate areas of knowledge, and from interested citizens and organizations as well. Therefore:	C	C	C
Plans reflecting these inputs should be clearly stated and announced to the public in an understandable form.	I	I	I
Agreed-upon plans should be fully implemented in a manner clearly evident to the public.	I	I	I
The effectiveness of planning should be periodically evaluated and the results reported to the public. Comments: The public needs to know about the new forest plans.	S	S	S
Needs for adequate staffing for the development, implementation, and evaluation of plans should be explicitly stated in Forest Service budget requests. Comments: Federal budget constraints may jeopardize recent gains.	S	S	S
Every member of the Forest Service should be committed to the principles of high-quality multiple use management and to the urgent necessity for putting these principles into practice. Comments: Commitment exists but performance must be stressed continuously.	S	S	S
Clearcutting:			
The Place of Clearcutting in Wyoming Silviculture			
Timber sale plans should include silvicultural prescriptions by qualified silviculturists and specific instructions for timber harvest; long-term evaluation of the effects of the prescription should be mandatory. Comments: Monitoring is needed today on all three Forests.	C I	C I	C I
In lodgepole pine: The Forests should continue to use clearcutting where it is a sound silvicultural harvesting method and in harmony with management objectives for the unit of land.	C	C	C

National Forests to Recommendations in the 1971 Wyoming Report

S = satisfactory compliance I = improvement needed

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
Alternatives to clearcutting, such as seed-tree and shelterwood cutting and overstory removal, should be used where such methods are consistent with the ecological requirements and protection of the species or appropriate to other uses of the forest land. Comments: Region 2 may have over-responded.	S	C	I
Thinning and sanitation salvage should be used independently or in combination with clearcutting where economically feasible. Comments: Shoshone and Bridger-Teton are active in salvage because of mountain pine beetle damage.	I	I	I
The present limitation on clearcutting in the Engelmann spruce-subalpine fir type should be continued until satisfactory regeneration practices have been developed. Comments: Recent successes have caused cutting bans to be lifted.	S	C	I
The Forests should consider using a light selection cutting or ''pussyfoot logging'' on low yield sites. Comments: The 1982 study team saw little evidence of compliance.	I	I	I
The Experiment Stations should vigorously carry out research to classify and define plant habitats and their ecological potential for both lodgepole pine and Engelmann spruce-subalpine fir forest types in Wyoming. Comments: Stations have complied but Forests are not using data aggressively.	S	S	S
Forest Service Research and Administration should speed up action to develop systems for analyzing the true costs and benefits of forest management alternatives. Comments: True cost benefit analyses are still in limbo.	I	I	I
Modifying Clearcutting Methods to Protect the Environment			
Clearcut size limits must be determined by the resource values to be considered and by the specific characteristics of the harvest area. Comments: Refinements for visual quality are needed.	S	S	S
More and better use should be made of the knowledge that specialists in soils, hydrology, and related areas can furnish in planning timber management operations.	C	C	C
Timber sale contract requirements providing for protection of live stream channels from unnecessary disturbance and from clogging with logging residue should be strongly enforced. Comments: Problems on old sales have not been corrected.	I	S	S

Table 6. Survey of Responses by the Bighorn, Shoshone, and Bridger-Teton

C = commendable progress

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
Research should determine (a) the kinds and sizes of areas and proportions of watersheds that can be safely clearcut at one time without creating damaging changes in streamflow quantity, quality, or timing; and (b) the nature and magnitude of changes in onsite nutrient content and of eutrophication of streams that may result from soil and vegetation disturbances that attend timber harvesting. Comments: Watershed research is still needed. Eutrophication research was conducted at Union Pass (Bridger-Teton).	I	I	I
Until more specific information becomes available, clearcuts in big-game habitats should be limited to 40 acres and should be no closer than 200 feet to existing openings.	C	C	C
Research and monitoring of wildlife behavior as affected by timber harvest should be encouraged in Federal and State agencies. Comments: The Gros Ventre Cooperative Elk Study (Bridger-Teton) is an example of current research. Monitoring needs further effort.	I	I	I
Unless wildlife budgets can be substantially increased, the costs of evaluating effects of timber harvest on wildlife should be properly considered a part of the timber harvest obligation. Comments: Current funding is not covering monitoring.	I	I	I
Multiple use planning should give particular attention to the long-term effects of timber harvest in limiting the options for future recreational use of land. Comments: EAs reviewed by the study team included recreation alternatives but emphasis is needed.	S	S	S
The Regions should encourage research that will help the Forests to achieve comprehensive recreation management appropriate to the desires of people and the potential of the land. Comments: Recreation opportunity spectrums research is being conducted by the Forest Service and universities. Non-wilderness recreation research is needed.	I	I	I
The basic character of Wyoming wildlands should be kept dominant, and manmade alterations held subordinate, in design of clearcuttings. Comments: No new clearcuts were observed on the Bighorn and Shoshone, therefore improvement over old clearcuts has not been demonstrated.	I	I	S
To do this: The design of cuttings, including size, shape, location, and dispersion should respond directly and specifically to visual characteristics of the landscape.	I	I	S

National Forests to Recommendations in the 1971 Wyoming Report (continued)
S = satisfactory compliance I = improvement needed

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
Scenic inventories, recording at least dominant landscape resources, should be made to aid in planning and design.	S	S	S
Forest personnel should be given training to develop greater managerial sensitivity to landscape resource values. Comments: Results of planning are not yet visible on the ground.	S	S	S
Roads:			
Road Planning and Maintenance			
Transportation plans should indicate the purpose of every proposed road--whether permanent or temporary, the disposition of each temporary road, and the maximum level of road construction needed to attain management objectives. Comments: Layout and design plans are issued periodically.	I	I	I
The transportation plan should be clear and logical, and presented in a form easily understandable to the public, and should specify drainages that will be exempt from any road construction or managed with temporary roads only. Comments: Road plans are not readily accessible to the public in an understandable form. New forest plans should help correct this deficiency.	I	I	I
The temporary roads still open should be carefully evaluated; those classified as temporary should be closed and all others reconstructed as required for maintenance as part of the permanent road system. Comments: Some existing roads open to use are not adequately maintained.	I	I	I
In road layout and design, the relation between the road and the landscape should be clearly established so as to avoid a result suggesting single use. Comments: New roads lay lightly on the land. Engineers working with landscape architects are producing visually sensitive road design.	C	C	C
Controlling Environmental Effects of Roads			
The quality of design, location, and construction of roads, especially temporary ones, must be greatly improved to avoid unnecessary damage to soil and water.	S	S	C
Existing specifications that temporary roads should be maintained for adequate drainage before winter should be scrupulously observed.	I	I	I

Table 6. Survey of Responses by the Bighorn, Shoshone, and Bridger-Teton

C = commendable progress

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
Much greater use should be made of geologists, hydrologists, and soil scientists in planning and constructing roads.	S	S	S
The Forests and Regions should actively encourage cooperative research to determine the impact of road systems on elk populations.	S	S	S
The Forest Service should carefully consider a slowdown in construction of new permanent roads until information is available concerning the effects of roads on elk. Comments: Slowdown has been due to economics as much as to elk research.	S	S	C
Road location and design should be better coordinated with the landscape than they are at present:	S	S	S
Planning and road design should routinely include thorough exploration of visual alternatives.	I	I	I
The visual corridors created by both existing and proposed highways and permanent forest roads should be recognized as requiring special attention.	I	I	I
More flexible road design standards, encouraging small scale roads where they are appropriate, should be adopted. Comments: Results show a better fit but oil and gas exploration roads present impact potential.	S	S	S
Logging Residue:			
Forest Service Research, National Forest Administration, and the timber industry should jointly explore possibilities for using more of the wood left after logging, and for treating the remaining residue to facilitate natural and artificial regeneration and reduce the unfavorable visual impact. Comments: The Union Pass study (Bridger-Teton) is an example of helpful research.	C	C	C
The Forest Service should establish exploratory studies to determine the effects of logging residue management on water quality.	S	C	C
The Forests should secure timely meteorological information, and require that logging residues be burned during periods when burning is least likely to affect air quality adversely.	S	S	S
The Forests should do a complete job of treating right-of-way clearing residues concurrent with construction of all roads open to public travel. Comments: The timber industry is critical of this recommendation because of increased costs involved.	C	C	C

National Forests to Recommendations in the 1971 Wyoming Report (continued)

S = satisfactory compliance I = improvement needed

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
The Forests should eliminate the backlog of untreated residue as soon as possible. Comments: The Bighorn is doing little clearcutting. The Shoshone considers residue beneficial. Old degraded sites still need correction.	I	I	I
Regeneration:			
The silvicultural prescription for each stand should include surveys to determine degree of serotiny in the stand and monitoring to forecast occurrence of seed crops and to estimate seed production.	S	S	S
A regeneration check list should be developed for each proposed timber sale, outlining (a) the sequence of events affecting regeneration and (b) the treatments needed to obtain satisfactory regeneration, including backup treatments to compensate for failure of any one step. Comments: The Bighorn and Shoshone may not be getting enough mineral soil exposed to assure timely regeneration.	I	I	S
Forest Stewardship:			
Making and Applying Management Decisions			
The Regions and Forests must better define resource management and environmental protection goals for the Forests and refine and update multiple use plans to include decisions that meet these goals.	C	C	C
Resource inventories should be completed for all major resources.	I	I	I
The Forests and Regions should strive toward a balance of resource skills in the Forest staff.	C	C	C
More effective use should be made of existing information by (a) the forester, who should search the literature for usable ideas, and (b) the researcher, who should work more closely with the forester in putting new methods into practice. Comments: Information networks have been established in both Regions.	S	S	S
Periodic evaluation of the results of management activities should be an integral part of the land management job. Comments: Limited response reflects general lack of monitoring.	I	I	I

Table 6. Survey of Responses by the Bighorn, Shoshone, and Bridger-Teton National Forests to Recommendations in the 1971 Wyoming Report (continued)

C = commendable progress S = satisfactory compliance I = improvement needed

1971 Recommendation	Evaluation of Response		
	Bighorn	Shoshone	Bridger-Teton
The Forest Service should strengthen the current research effort in Wyoming and should explore ways of using abilities outside the Service to develop needed information without delay. Comments: The early 1970s saw some accomplishments but current research funding is lacking.	I	I	I
No industrial harvest should be undertaken unless adequate funds and manpower are available to do a complete, professional job.	C	C	C
Tenure and transfer policies should assure that quality land management is not itself sacrificed to provide land managers with the training and experience they need to achieve quality management.	I	I	I
Forest Service internal inspection procedures should be reviewed to determine why questionable practices were not detected before they provoked public criticism. Comments: Something is still remiss when Jules Bowl and Moose Creek continue to provoke public criticism.	I	I	I
The Forests and Regions should evaluate timber harvest areas that have drawn repeated public criticism and begin major rehabilitation programs where necessary to improve the visual image and protect other resource values.	I	I	I
Unifying Management Policies			
The Regions and Forests should strive for an underlying consistency in policy through good planning, but should preserve the flexibility needed to insure that management practices are appropriate to site conditions. Comments: Communication regarding consistency is needed between Regions.	I	I	I
The Forest Service should seek statutory authority to modify contracts to protect environmental values.	C	C	C
Involving People			
The Forests should make every effort to involve the public in the planning process by (a) identifying appropriate land management alternatives through listening to people and giving them forest resource information and (b) assessing public opinion as to choice of alternatives. Comments: Special efforts to encourage public participation in developing new forest plans must be continued to insure public understanding of management alternatives and environmental impact statements.	S	S	C

Summary of 1983 Recommendations

Considerable change has taken place in forest management since the 1970 study. Progress is impressive. Harvesting of timber is no longer considered the sole forest value. The importance of wildlife, recreation, and esthetic quality is being better recognized than before. Forest personnel report that change has come partly as a result of the 1970 study, partly as a result of recent legislation, and partly because of the desire of forest personnel to do a professional job of land management. Progress must continue or gains will be jeopardized and resources will suffer.

Some old concerns remain. Some past mistakes have yet to be corrected. Some procedures used now, though adequate, need refinement.

New forest plans, new federal legislation, and evolving forest resource uses (oil and gas exploration and development prominent among them) are presenting new and different challenges for forest managers. The study team concludes its 1982 report with a summary of recommendations highlighting areas of concern now and for the years ahead. New recommendations are taken from the text of previous chapters and should be considered in the context of discussions presented.

Policy: New Directions

Planning Process

In the environmental assessment process, inventories of timber, wildlife, landscape, recreation, and archeological resources should be conducted prior to formulation of management alternatives.

The Forests should establish more effective monitoring programs, perhaps calling on Forest Service research staffs to train and advise personnel.

The Regions and Forests should consider coordinating public information programs to keep local communities informed about new forest plans, differences in Forest programs, and developments in natural resource technology.

Regional Foresters and Forest Supervisors should consider re-establishing citizen multiple-use advisory boards and expanding citizens consensus groups to encourage public involvement in forest planning and management.

Economic Perspectives

The Forests should inform the public of economic considerations in planning and decisionmaking.

The Forests should explain how relative weights are applied to decision factors, how they are derived, and what influence public expressions of forest values have in decisionmaking.

Local-State-Federal Coordination

The Governor and Regional Foresters should explore, among other types of coordination, advantages of negotiating a memorandum of agreement on forest planning.

The Forests should explore ways to insure that local governments receive complete information and are consulted prior to proposed actions of local interest.

Timber Harvesting	Forest personnel should use silvicultural terms consistently and according to standard definitions.
	Research should develop guidelines for regeneration harvests in stands with varying degrees of serotiny.
	Silviculturists should consult with wildlife, landscape, and recreation specialists to prepare silvicultural prescriptions designed to enhance non-commodity values.
	Research should develop guidelines to achieve desirable species mixtures in lodgepole pine stands for wood production, wildlife habitat, and esthetic values.
	Research should develop guidelines for stocking and thinning of lodgepole plantations to promote both wood production and big game cover as early as possible.
	The Forests should use habitat type information in designing silvicultural prescriptions.
	The Forests should develop a procedure for the systematic recording of local habitat type observations by specialists.
	On all timber sales, but particularly on controversial sales in previously unroaded areas, the Forests must comply with environmental assessments to accomplish stated objectives on the ground.
	The Forests should analyze definition, interpretation, and application of the term potential yield and develop terminology for common use.
	The Forests should review timber harvest schedules and adjust if necessary to avoid creating critical timber supply situations on all components of regulated commercial lands.

Wildlife Habitat

Timber stand improvement thinnings should be designed to meet wildlife cover and landscape design requirements.

The Forests and Regions should make a concerted attempt to maintain full-time assignments in wildlife positions.

Regional offices should consult with forest biologists and develop procedures through which existing data-base programs can be more fully utilized in management.

Research should be encouraged to develop specific habitat prescriptions for deer, moose, and small birds in Wyoming forests.

Forest Service research and the State of Wyoming should be encouraged to assist the Forests in developing sampling systems adequate for inventory and monitoring of wildlife habitat and populations.

The Forests should coordinate seasonal road-closure programs with wildlife management goals of the Wyoming Game and Fish Department.

Road-closure programs should be vigorously pursued in all situations where open forest roads significantly reduce habitat effectiveness for elk.

Landscape Design

The Forests should identify wildlife, recreation, and scenic values with national significance and recognize them in management decisions.

Landscape architects should, to the best of their ability, use professional judgment when applying the Visual Management System.

The Forests should involve landscape architects in services beyond general planning, EAs, and crisis situations to include landscape design, on-the-ground advice, and monitoring.

Visual monitoring should be essential on a full array of resource management activities.

Rocky Mountain landscapes native to the three Forests should serve as models for maintaining visual diversity.

Hydrology

Protective vegetation and logging debris should be maintained on timber harvesting sites to prevent accelerated overland water flow.

Skid trails should be drained at frequent intervals to prevent concentrations of water that would erode rills and gullies.

Where increased forage on timber harvest areas has resulted in intensive grazing and trampling disturbance, the Forests should institute livestock management measures to minimize damage to riparian sites and regeneration.

The Forests should conduct periodic and frequent evaluation of the effects of timber management activities on water quality as an integral part of the land management job.

The Forests should monitor streamflow for water amount and time of flow to evaluate timber management effects on water yields.

Research should determine the kinds and sizes of areas and proportions of watersheds that can be safely clearcut at one time without creating damaging changes in streamflow quantity, quality, or timing.

Road Design and Maintenance

The Forests should indicate in transportation plans the purpose of every road and the level of road construction needed to attain stated management objectives. Plans should be logical, presented in a form understandable by the public, specifying drainages that will be exempt from road construction or managed with temporary roads only.

The team repeats a 1971 recommendation that ''roads still open should be carefully evaluated, those classified as temporary should be closed, and all others reconstructed as required for maintenance as part of the permanent road system.''

The Forests should continue to improve the quality of design, location, and construction of new roads to prevent damage to soil and water.

The Forests should insure that road location, design, and construction is coordinated with the landscape. This will require thorough exploration of visual alternatives, special attention to visual corridors, and the use of flexible road design standards that encourage the smallest scale road for the proposed use.

The Forests should strive for consistency in road-closure policy and commitment to road-closure performance.

The Forests should involve the public in planning road closures and insure that reasons for road closures are understandable and in the interests of forest resources.

Staffing and Funding

The Forests should make a concerted effort to retain specialist positions essential to quality multiple-use management or to adjust scheduled accomplishments to levels consistent with the qualified staff available.

Recreation

The Regional Foresters should recognize the national significance and the unusually high impact of recreation on the Bridger-Teton and Shoshone and, insofar as possible, allocate funds to accommodate this use.

Oil and Gas Exploration

The Forests should cooperate with the Interior Department in keeping local and State agencies informed on oil and gas activities.

Forest personnel should keep the public fully informed concerning oil and gas exploration and development proposals especially for unroaded areas.

Site Rehabilitation

The study team repeats the recommendation made in 1971: The Forests and Regions should evaluate timber harvest areas that have drawn repeated public criticism and begin major rehabilitation programs where necessary to improve the visual image and protect other resource values.

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